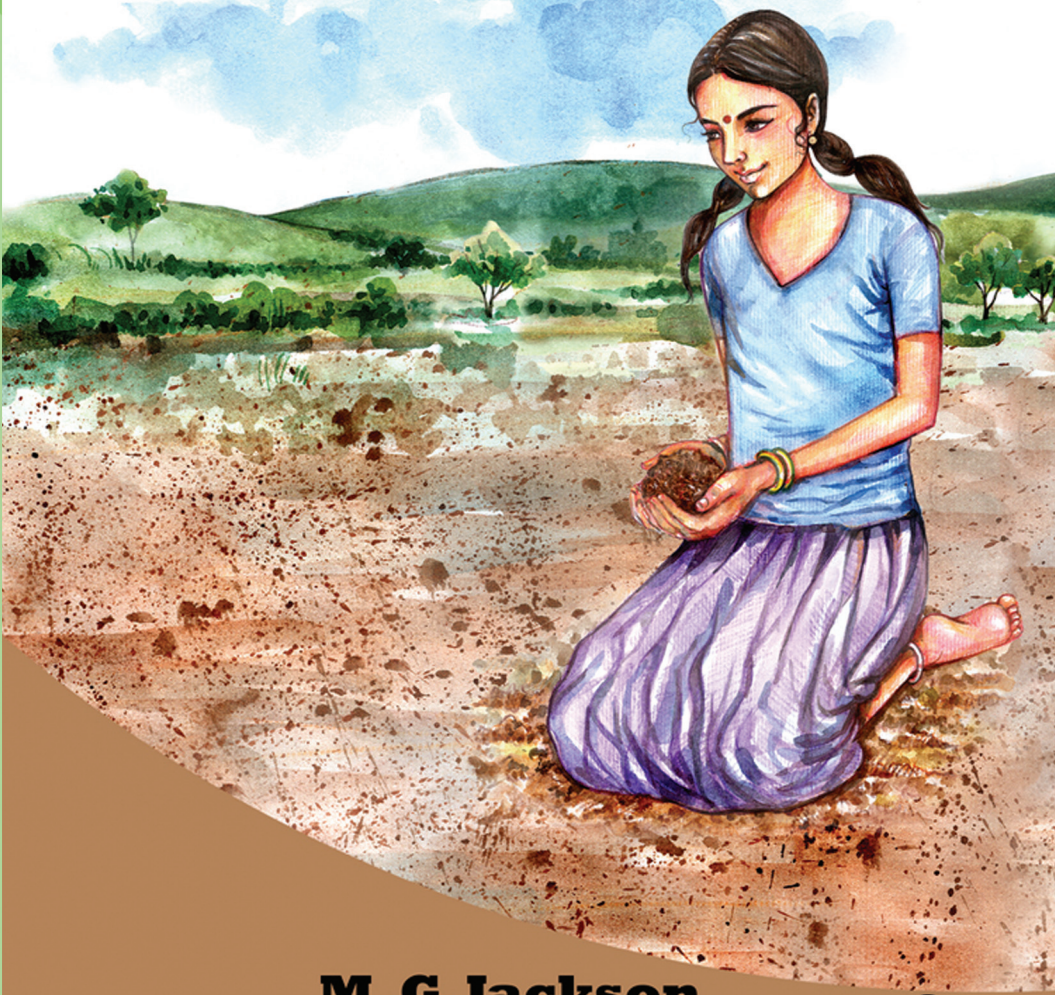
A FUTURE FOR RURAL INDIA

ECOLOGY, EQUITY, EMPOWERMENT



M. G. Jackson

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A Future For Rural India

Ecology, Equity, Empowerment

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A FUTURE FOR RURAL INDIA

Ecology, Equity, Empowerment

Author : M.G. Jackson

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In memory of my wife Pramila

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Preface to the Second Edition

My purpose in writing the essays in this book has been to suggest entirely new ways of thinking about the present crisis of rural India. It is abundantly clear that the policies and programmes now being pursued are not working. Indeed, they are, at best, mere palliatives. When they are examined critically they can be seen as stemming from the same mindset that has created the crisis in the first place. I refer, of course, to the concepts of 'development' and 'globalisation', and to all the underlying assumptions about who we are and what the world is like that legitimise these concepts. The real challenge, therefore, is to question these concepts and their underlying assumptions. If this is done thoroughly and systematically, their illogicalities and incoherence will be revealed. Then we must attempt to visualise alternatives. Little can be expected in this regard from scientists, administrators, policy makers and politicians.

Fortunately there are many other people who are attempting to meet this challenge of 'learning to think differently', and it is to them that we must turn for guidance. Many village communities, individual farmers, non-government organisations (NGOs), and the rare scientist and bureaucrat are struggling to articulate and give substance to an alternative vision of the future of rural India. Broadly it is a vision in which village communities define, or rather redefine, themselves in the present world context, control their traditional natural resource

base, manage it for sustainable production, and overall make their own collective decisions. They participate with state and business interests on an equal footing in determining local and national priorities and policies.

The title of this book was chosen to indicate my belief that the guiding principles of such an alternative vision must be ecological. If such principles are understood and acted on, equity, both among persons within the village community and between rural communities and the rest of the nation, becomes an inevitable subordinate principle. Similarly the principle of empowerment – of individuals within the community and of the community as a whole – becomes the operational strategy for achieving this vision. The purpose of this collection of essays is to articulate a coherent and comprehensive conceptual framework for achieving healthy rural communities.

This collection of essays was first published in 2005 by The Other India Press under the title The Ecological Village, though the essays themselves were written between 2000 and 2002. Ten years on, the trends of ecological destruction, economic decline and social decay have dramatically accelerated, further strengthening the argument for a radically alternative development model for rural India.

Since the writing of the original essays that comprise this book three important developments have occurred that have made it necessary to revise many of them. First, a critical study of the village ecosystem model has been completed by my colleague in the Uttarakhand Environmental Education Centre (UEEC) at Almora, Suman Pande. The results of this study have given us a much more realistic view of the model, its possibilities and limitations. My earlier approach to the model was quite mechanistic. This is a tendency of many, probably most, scientists who have begun working with systems in mid-career. I am happy to have moved on in this respect since then. The results of Suman's painstaking field research have replaced the more speculative treatment of the village ecosystem model as a planning tool based upon less reliable students' data that originally featured in Chapter 1.

Second, I have given considerable attention since 2002 to the challenges of agricultural research in the hill region of Uttarakhand through my involvement with the scientists of the Vivekananda Institute for Hill Agriculture in Almora in workshops and training programmes. This led to a paper in the Institute's publication Sustainable *Production from Agricultural Watersheds in North West Himalaya* (Gupta et al., 2006) which I feel will contribute significantly to the theme of this book. I have accordingly edited it suitably for inclusion in this revised edition as Chapter 4. I thank the editors

for giving me permission to do so. (As a result of this addition the number of chapters has increased from eight to nine.)

Chapter 4 offers a view of settled rural communities in the Northern mountains who are refusing to adopt modern 'scientific' agriculture, or are accepting only those aspects of it that seem to them suitable to their situation. Their reasons for their decisions about what is suitable often elude the understanding of the scientist. Their reasons are logical in terms of their own worldview, environment and life circumstances. Over the centuries they have fashioned a fairly sustainable land-use system. It is argued that scientists need to make the effort to understand this system and to encourage rural people to regain their traditional role as innovators. The role of scientists would be that of facilitators of the process.

Finally, I have given much more thought to the critique of present-day science and of the worldview of which it is an expression. The results of this have now appeared in my books *A Return to the Perennial Questions: Fresh Answers for Our Times* (Jackson, 2013 a) and *Learning the Ways of Things: A New Protocol for Science* (Jackson, 2013 b). I have therefore taken this opportunity to revise Chapter 5 somewhat to bring it into line with my current thinking.

I wish to thank Earthcare and Permanent Green for agreeing to publish this book and for the fine job they have done with it.

M.G. Jackson

Preface to the First Edition

From 1963 to 1982 I was a teacher, research worker and administrator at the G. B. Pant University of Agriculture and Technology at Pantnagar in the Tarai region of Uttarakhand, at the foot of the Himalayas. During these years this university was a pioneering institution in ushering in the green revolution (GR) in India, and I was an enthusiastic participant in this process. By the late 1970s, however, I began to have serious misgivings about the GR. Was this really the way to go about achieving food security and rural welfare in the future?

Before my Pantnagar days, in the late 1950s, I was a post-graduate student of Agronomy at the Raja Balwant Singh College in Agra. While there, and quite independently of the curriculum, I made a study of the serious land degradation that had been caused, and was continuing to be caused, by traditional Indian farming. Defective village forest management had reduced village forest to treeless eroding 'grazing land' or 'wasteland' everywhere, and ploughing and clean weeding over centuries had caused extensive soil loss. These problems were not, however, addressed by the GR: indeed, the GR has simply added a new set of problems - uncontrollable crop diseases

and pests, falling water tables at places and water-logging at others, chemical pollution of soils, groundwater and food, reduced biodiversity and farmer indebtedness.

The result of all this was that by 1980, I began actively to question both modern and traditional farming. To me both seemed unsustainable, though for different reasons, and to different degrees. I began to search for a possible alternative to both.

In pursuit of this aim, I made a study of the traditional farming in the hill region of Uttarakhand, a so-called backward area, which means that farmers had largely rejected GR technology in favour of their traditional farming practices. It was here that I developed the concept of the village as an ecosystem. This has proved very useful in understanding both the strengths and weaknesses of traditional Indian farming, and in developing a critique of modern GR farming.

At that time everyone, GR farmers and scientists, administrators and politicians, looked askance at anyone speaking or writing about a need for alternatives to modern agriculture. I persisted, however, and published evidence for the harmful 'side-effects' of GR farming began to come in, confirming my earlier misgivings. By the 1990s there were sizable numbers of farmers and scientists advocating alternatives to the GR. Some of them also began looking to ancient farming practices for guidance.

In 1982, for private reasons, I resigned my position in academia and, with my wife, went to live in the Mirtola Ashram in the Kumaon Hills of Uttarakhand. There I participated in GR farming, in an ongoing experiment that I had myself, while at Pantnagar, helped initiate. This experiment was made possible by a small-scale water harvesting and irrigation system developed at Mirtola itself. Thus I laboured in the fields of 'high-yielding' wheat and maize, and fed, milked and doctored crossbred cows. However, my earlier enthusiasm continued to wane. I was, at the same time, also further observing traditional farming in the villages surrounding Mirtola and became more acutely aware than ever how irrelevant GR technology is to improving it in any way.

During my Mirtola days I began to read about natural farming. I was particularly impressed by Albert Howard's *An Agricultural Testament* (Howard, 1940), Masanobu Fukuoka's *The One Straw Revolution* (Fukuoka, 1994), and the *Organic Farming Sourcebook* (Alvares, 1999) which documents the experiences of several hundred Indian farmers who are pioneering alternative farming systems all on their own.

During the 1980s and 90s, while living at Mirtola, I also worked informally with a local non-government organisation (NGO), the Uttarakhand Environmental Education Centre (UEEC), Almora, designing a school course on improved land management based upon a blend of traditional and natural farming practices. This project helped me clarify and organise my thoughts about the possibilities for sustainable agriculture.

In 1999 I came into contact with the Asian Agri-History Foundation in Secunderabad, a non-profit organisation formed by a group of agricultural scientists to promote the study and interpretation of Indian agricultural history. This association helped me to look at current problems from a historical point of view.

***

The central idea of this book derives from a perception I had some 25 years ago when I first began to ponder the shortcomings of the GR. I saw very clearly then that an alien technology could not be put to effective use unless the mindset of the people of the society that produced that technology was adopted first. The GR was possible only because we had internalised the Western concept of 'development' and the materialist science paradigm it assumes. The prelude to this had been some two centuries of 'modernisation' on a Western model under colonialism. During the 1950s and 60s the process was more or less completed; we rejected our traditional worldviews for the hedonistic, rationalistic materialism of the West.

Subsequent events, however, showed that the change in worldview was superficial; the new view did not replace the older ones, but only overlaid them. It was confined to our public and professional lives. The older worldviews

remained very much alive, even if suppressed, and when misgivings about the GR began to occur in the 1980s, many people began to reconsider them. To do this systematically and impartially, it seemed to me essential to undertake a thorough-going critique of modern science and the notion of 'progress' underlying it. It became clear also that we lacked an adequately articulated rationale for the many contemporary natural farming and community forest and water management initiatives that are occurring spontaneously at the village level. We needed a better understanding of ancient and tribal worldviews and the farming systems they have given rise to, as also an explanation for the apparent similarities between these and contemporary 'post-modern' or 'ecological' worldviews. The essays in this book address all these issues.

***

In writing these essays I did not begin with a comprehensive blueprint; the outlines of my arguments took shape only as I wrote. The reader will perceive a progressive development and refining of ideas and arguments since the essays are given in the chronological order in which they were written and published. New points of view suggested themselves as I proceeded. Ideas were gradually elaborated, often being introduced initially in a very tentative and summary way. Nevertheless, taken as a whole, these essays present a coherent and logical system of ideas that can form the basis of an alternative vision of the future for agriculture and village communities. This system proceeds from an alternative worldview, neither old nor new, though utilising both ancient and modern ideas. Such an alternative worldview appears to be necessary to a solution of most of the global problems of our time.

Take the problem of crop pests, for example. It is largely the creation of modern science. Having created the pests, the same science dictates that we must fight them. The evidence however, indicates that we are fighting a losing battle – and at the same time polluting the environment and poisoning ourselves. Albert Howard has pointed out that there are no pests in nature. If we design our farming in imitation of nature, there will be no pests and hence no need to fight them. He demonstrated that this is possible, and thousands of farmers

in India and elsewhere are today doing likewise. If there is a 'pest problem', he tells us, it means that the management of our crops is faulty, that we have in some way deviated from the way of nature. Examples are: incomplete recycling of biomass to the soil, non-adapted species or varieties of crops, disruption of natural processes by the application of chemicals. Howard's approach is obviously based upon entirely different assumptions than those of modern science. It seems to me to offer a way forward for agriculture in the future, and accordingly, I have devoted much attention to explicating this alternative science paradigm. This paradigm is, however, at odds with the core values of the worldview of contemporary global culture; it demands an alternative worldview for its legitimacy. The shape of such an alternative worldview is therefore also sketched.

In situations where a satisfactory solution of a problem does not seem possible within the framework of a given set of premises, it is axiomatic that we must examine those premises. This, however, is extremely difficult. So identified are we with our particular set of premises, our own worldview, that we fail to understand that the basis for it – for any worldview – is not fact, but supposition. We also lack the metaphysical acumen to make our suppositions explicit, and so we are unable effectively to criticise our own worldview – and hence of making changes that are needed for our survival. The point of view from which I write, then, is that only a change in worldview will enable us to envision and hopefully to achieve a sustainable future. Also implied in my point of view is the notion that over long periods of human history existing systems of ideas – social, economic and scientific – function well enough, but that there arise points of crisis, of impasse, to resolve which new ideas are necessary. When this happens key ideas for a new system appear spontaneously; we then have to labour to make them explicit and to elaborate them in new ways of thinking and living. I am convinced that the turn of the 21st century is such a time.

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Several well-defined themes run through this book, themes that are woven together to give the fabric of the alternative vision of the future. The major

ones are five in number. The first of these is the historical theme. Today, people in all walks of life, and not least farmers, agricultural scientists and members of rural civil society social service organisations (Non-Government Organisations or NGOs), feel a need to reconnect creatively with their cultural past as a corrective to the unsustainability, meaninglessness and sterility of modern consumer culture. The essence of all traditional cultures, I suggest, is a set of universal human intuitions. The first of these intuitions is of the livingness of all things, even of those things we conventionally consider inanimate. A second intuition is of the ultimate mystery of life, and hence its sacredness. Third is of the interconnectedness of everything. (The 'everything' here includes me also.) These intuitions, though variously expressed in different cultural settings, give meaning and direction to life, and ensure sustainable modes of human interaction with nature. With the rise and spread of the European materialist worldview, these healthy intuitions have been suppressed. Nevertheless, it seems to me that these very intuitions are again at work today in the formulation of the post-modern or ecological worldviews that are the implied rationale for the many experiments on alternative modes of living and farming now underway.

A second theme is natural farming. This has a philosophical and scientific rationale distinct from modern, market oriented, chemical agriculture, and also from such other forms of alternative farming systems as organic, low external input sustainable agriculture and permaculture. The natural farmer takes as his or her model the natural state of the local ecosystem before farming in that locality began. That is, he or she tries to preserve to the extent possible, or at least to imitate, the natural processes occurring in that ecosystem. Those processes are, to the extent necessary, gently redirected to produce the types of biomass he or she and his or her family need for their sustenance, all the while respecting the biological limits of the ecosystem so as not to impair its health. In this way sustainability is ensured. This is not primitive farming; it requires more, and more detailed, local knowledge of nature than modern farming, involves more subtle and sophisticated concepts, and the use of intuitive knowing as well as discursive reasoning. The farmer must feel himself or herself a part of the ecosystem. Its rationale can be formulated in

ecological terms and also in terms of traditional concepts as expressed in myth (such as, for example, that of Mother Earth). If correspondences between the two can be seen, so much the better. Albert Howard's 'Nature' (spelled by him with a capital 'N') as a model and guide can, perhaps, be seen as analogous in a present-day setting, to the Mother Earth of the ancients.

The third general theme running through these essays is the scientific one. The argument here is that an alternative scientific theory is essential to achieve sustainable agriculture. To visualise this possibility we must be able to see that modern, materialist science is not the last word when it comes to understanding the natural world. Judging by the environmental crises we face, it is not even the best explanation for our times. The sciences of traditional cultures were certainly more adequate than ours in terms of enabling people to live in harmony with nature. Entirely new theories are beginning to take shape which are generally congruent with the scientific theories of traditional cultures, though expressed in a different idiom. They assume an alternative theory of causation, a systems explanation of nature, and an entirely different research methodology. It offers a formal scientific rationale for natural farming.

These alternative scientific theories derive their legitimacy from an alternative worldview. I have endeavoured to make this worldview explicit.

It is argued in these essays that sustainable agriculture can only be achieved by sustainable human communities, and that to achieve the latter a comprehensive process of social restructuring is necessary. There are several aspects of this. One is that patriarchy and caste are seen today as being obstacles to achieving a sustainable society. Initiatives to remove them are coming from government in the form of Constitutional directives and administrative policies, and from the oppressed themselves. The empowerment of women and Dalits is not, of course, to be seen as a means to achieving sustainable agriculture or communities, but as ends in themselves.

Another aspect of social restructuring is the need to introduce whole-community democratic forms of governance into the traditional representative form of governance (panchayats). I am speaking here of the village community

since we are considering agriculture and rural life in general. Democratic governance movements, in the form of village women's groups and community land and water management projects are appearing spontaneously.

Social inequalities are exacerbated by inequalities in land ownership. Our post-independence land reforms agenda has not been completed in many areas of the country. And, it has even been expanded to include land ownership for women, and the legal recognition of tribal societies to the continued use of their ancestral lands.

Empowerment of the presently socially disadvantaged, and the democratisation of village governance are onerous tasks. The village community has lost its traditional coherence, young people are alienated from traditional village life, non-farming rural livelihoods have been destroyed as a result of large-scale, urban-centred industrialisation, the GR and free trade market economics are destroying farming itself, and dangerous reactionary forces have been activated. An attitude of helplessness, dependency, opportunism and intense frustration are the norm in rural India. Tackling all these degenerative trends in rural social life leads to a fifth theme, namely the need to reverse the globalisation process by a well-thought-out, comprehensive process of localisation.

Localisation consists in valuing diverse cultural traditions, a focus on community, ecologically-sound, community-scale livelihood technologies, local trade (as in traditional local markets), local food security before export to cities. This implies a reversal of the large-scale, urban-based industrial development model we have followed since independence, import restrictions/ duties to protect local livelihoods, and a concerted effort to improve government health and educational services rather than allowing companies to make businesses of them. If government disengages itself from directly providing these services to the village community, at least at the primary and secondary levels, and instead helps empower the community to take them over, so much the better. Government forest land would need to be returned to village ownership and management.

Globalisation, it is argued in this book, can be viewed as a continuation of the modernisation of India on a Western model. The process began with colonialism. This took on a new incarnation as 'development' after independence, and 'development' has now been subsumed by globalisation. To aid this process, an indigenous elite class was created and sustained during the colonial period by a system of enhanced social and economic status. This class has persisted after independence. There has also been an improvement in living standard for the middle class, and the successful GR farmer. Some crumbs have fallen from the high table to the poorer classes. However, such modernisation is not in our larger national interest; on the contrary, it is a means by which foreign countries and corporate interests gain control of our economy and our lives.

In questioning modernisation on the Western model, however, we must not lose sight of the very real benefits that it has also brought: a democratic, secular form of government, the rule of law, widespread education and an affirmative action policy for the socially disadvantaged. While the functioning of all these processes is sometimes a cause for anxiety, the fact remains that they are in place and operational more than 50 years after independence. They provide the essential framework within which we have the freedom to question the mainstream globalisation agenda, to visualise an alternative future and to work constructively for it. Globalisation is now threatening this framework itself - both in India and in the West.

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Chapter 1, in addition to serving as a general introduction to the entire book, presents the concept of the village as an ecosystem. This allows us to deploy ecological concepts to understand familiar phenomena in new ways, and provides a management tool for ecosystem restoration. The point is made that the village ecosystem, though apparently stable over millennia, was gradually deteriorating even before the advent of the GR due to the inadvertence of the village community. This indicates that making farming sustainable in the future is a two-fold task: reversing the degenerative trends under traditional farming

and repairing the damage done by the GR - and, to begin with, changing the ways of thinking that are responsible for both. The problems of traditional farming – primarily village forest destruction and consequent soil erosion – require community action. Community initiatives in this direction are described. They are occurring mostly in the non-GR areas of the country.

Chapter 2 defines natural farming as developed by Albert Howard in India and by Masanobu Fukuoka in Japan. The focus of these two pioneers and the numerous practitioners throughout the country today is the individual farm. I have enlarged their definition to include the management of the entire village ecosystem. The several specific propositions constituting this definition can also be used as criteria for evaluating any system of farming for its sustainability. They are so used in Chapter 3 to evaluate traditional shifting cultivation, traditional sedentary Indian farming, and GR farming. From the sustainability perspective traditional shifting cultivation ranks highest, traditional sedentary farming next and GR farming last.

If unsustainable modern agriculture is a product of contemporary science, then perhaps, I argue in Chapter 4, that science is defective. By examining its basic assumptions, these defects are clearly revealed. An alternative set of scientific theories is proposed – systems or ecological theories. Farming according to these theories is described. Such farming resembles natural farming. A metaphysical rationale for these theories is suggested. That is to say, an alternative worldview that legitimises them is outlined.

There is considerable confusion today over how to interpret Indian agricultural history. Four distinct theories appear to be implied by agricultural historians. In Chapter 7 these are described and evaluated in terms of how well they account for historical fact and how well they help us derive guidance from history in creating sustainable farming systems for the future. But this exercise is not feasible in the absence of a thorough understanding of the Vedic worldview, the European enlightenment concept of progress, and of what constitutes knowledge. The first of these is the topic of Chapter 5, and the last two are covered in Chapter 6. These topics prepare the groundwork for the evaluation exercise in Chapter 7.

Of the four theories of history described, the one termed the 'theory of universal intuitions' is judged most adequate. According to this theory, universal human intuitions inform the worldviews of Vedic times as well as those governing traditional tribal agriculture like shifting cultivation. They appear to be finding expression today in the practice of natural farming. This theory can account for the large measure of congruence among all these.

Finally, in Chapter 8, the implications of the alternative science paradigm and localisation for agricultural education and research are considered. These were functions of the village community before the advent of modernisation and the way they were pursued is reviewed. It is concluded that the focus of both teaching and research in the future should shift from the university and the research institute to the village. The ways in which university teachers and research workers might assist village people to reconstruct these functions are suggested.

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All the essays comprising this book first appeared in the Asian Agri-History journal published by the Asian Agri-History Foundation. Y. L. Nene, Chairman of the Foundation and Editor of the AAH journal, has been very receptive to the ideas developed in these essays, greatly encouraging me to go on with my writing. His editorial suggestions from time to time are gratefully acknowledged. He has given me permission to include these essays in this book. Through the Foundation I have established contact with a network of scientists, some of them former colleagues with whom I have been out of touch for two or three decades, and with whom I find a shared interest in an alternative future for Indian agriculture. Several of them have offered comments on various of the original essays, either directly or through the columns of the AAH journal, which helped me refine my arguments. I thank P. M. Tamboli, R. C. Pant and K. L. Mehra.

Most of the original essays have been revised for inclusion in this book. Chapters 5 to 7 were originally published as one paper with the title 'In search of an adequate interpretation of Indian agricultural history'. It was, however,

unwieldy and too long. Here, therefore it has been broken up into three distinct chapters. Chapters 2 and 3 appeared originally as one essay 'Let us take another look at *jhum* cultivation'.

I am grateful to Lalit Pande and the staff of the UEEC for providing a congenial, stimulating environment in which to work. Lalit Pande, Anuradha Pande, G. P. Pande and Kishen Singh Suyal read drafts of many of these essays and offered suggestions. G. P. Pande made the diagrams in Figures 4, 5, 6, 8 and 9 and did the general formatting of the book.

I wish to thank B. D. Pande for several valuable insights into Vedic culture, and for the loan of several books on this subject, and Neera Kashiyap for several very useful comments on the original essay 'A future for the Indian village'.

Y. L. Nene supplied the diagram of the village ecosystem in Figure 1. Figure 3 and the drawings of the *kurmula* beetle and grub were done by Deepa Pant. I am grateful to them.

I have long admired the unique publishing venture of the Other India Press. It is therefore a matter of great satisfaction to me that this book of essays is being published by them. Claude Alvares, editor of the press, encouraged me in my writing with favourable comments on the essays I shared with him from time to time and offered many valuable editorial suggestions on the manuscript I originally sent him.

M. G. Jackson

Almora
Uttarakhand
August 2004

A Future for Rural India

During the past two and a half centuries, and particularly during the second half of the 20th century, traditional village life and systems of land management have been destabilised causing the decay of the village as a community and a decline in the productive capacity of most of our land. The causes of this are many; chief among them are the politicalisation and monetisation of village life, government forest and development policies and programmes, the development of transport and communications, international free trading and foreign agricultural technology fostered by big business. If, in the years to come, rural India is simply left to find its place in the (liberalised) national (that is, global) economy, these trends of decay and decline will only be accelerated, leading to increasing marginalisation and hardship for rural people. Such, at least, is the view of many rural NGO personnel and those people who have spontaneously undertaken self-help ameliorative programmes in their own villages. They are struggling to formulate an alternative view of the future in which the people of rural India will be able to achieve by their own efforts a reasonably comfortable and secure life and the land will be rehabilitated and managed for sustainable production to secure the collective welfare of all.

The traditional Indian pattern of land use

If we do not see any future for rural communities or for productive, sustainable land use in the global market economy, what is the alternative? The traditional system of community life and land use, in broad outline, could be taken as the starting point for the formulation of an alternative view. Traditional Indian farming has a continuous history of several thousand years, which is surely reason enough to consider this suggestion, given that green revolution (GR) farming has proved itself unsustainable in a mere 20 years or so (Alvares, 1999; Bose, 2000; Dasgupta, 2000; Shiva, 1992; Third World Network, 1994). We will begin our consideration of this suggestion by attempting to describe the system. In doing this it is essential to look at rural life and the land which supports it as a system, in the sense that all natural phenomena are intimately interconnected. The modern tendency is to see at any one time only cultivated land, 'wasteland', cattle, people, rural industries, health care, school education, and so on, and not the system of which they are parts. The science of ecology, on the other hand, can help us to focus on the system, thus unifying this apparently diverse array of things and activities. The concept of the village as an ecosystem will guide our enquiry.

The best places to study the traditional system are the so-called backward areas, isolated until recently, where the GR has not been adopted.[1] Uttarakhand is one such area, and I draw heavily on my experience of working in this region, but I believe the system is basically the same throughout the country. I will therefore speak of a common Indian system.

The traditional Indian farming system

The central feature of settled human occupation of the land in the entire Indian peninsula is the village, a distinct social and geographical entity. I will not attempt to describe the village in social terms in any comprehensive way, but simply note that it is traditionally a more or less self-governing community that collectively manages the land on which it is settled. Geographically, a village generally consists of a cluster of houses established near a reliable water source and surrounded by, or adjacent to, cultivated land created by clearing the original forest. Domestic animals graze in the uncleared forest in

more distant parts of the village and those parts that are less suitable for cultivation. The forested areas also provide fuelwood, stemwood (for house building and making farm and household implements), hand-cut green tree-leaf fodder to supplement grazed fodder, and, in colder seasons and regions, dry fallen leaves for use as animal bedding. Further, the forested parts of the village are usually the major contributors to general village groundwater recharge. When settlements were few, uncleared forest areas were extensive in relation to the areas of cultivated land and village boundaries were probably vague, but became more distinct as the number of settlements increased. Milk is an important item of food and bullocks are used for draught. Animals are stabled at night and the dung produced at night is traditionally used to manure cultivated land. In essence this remains till today the Indian system of land use. The main features are depicted diagrammatically in Figure 1.1.[2] The arrows represent flows of water and materials among the main components of the system, uncultivated and cultivated land, people and domestic animals.

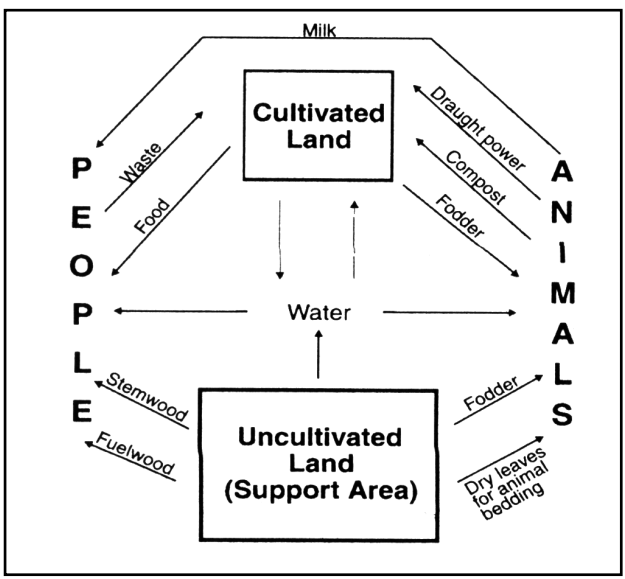


Figure 1.1. Schematic representation of the traditional Indian system of land use. Uncultivated land, originally forest, is the primary producer of biomass that supports the entire system; hence is termed 'support area'. It includes privately-owned and village-owned land, and government-owned forest land to which the residents of the village have legal rights to gather fodder, fuelwood and water.

The essential feature of the farming system is the transfer of biomass from uncultivated to cultivated land, with trees playing a crucial role as producers of primary biomass which, as it were, drives the entire farming system. Figure 1.1 is a conceptual model and not a geographical reality. As we shall see later in this chapter, and in Chapter 3, where the proportion of tree area in the farming system has been reduced below a threshold level, efforts will have to be made to increase it to achieve sustainable farming.

An objective assessment of the traditional system of land management must take into account the considerable evidence for land degradation under this system in the shape of deforestation and excessive soil erosion. To do this we must look back in history to a time before the advent of modernisation. Modernisation or development, including lately the GR, have no doubt exacerbated these twin problems, and added new ones, but for our immediate enquiry its effects can be discounted.

Land degradation under traditional farming

The traditional system of land use is inherently unsustainable because the practice of grazing livestock in forest stops tree regeneration. Grazing is only appropriate in areas of grassland biome.[3] Grazing animals stop tree regeneration by eating many broad-leaved tree seedlings and trampling others. As the village forest (or 'support area' – see Figure 1.1) tree cover thins, biomass output declines. This feature of the traditional land-use system is not widely perceived even by village people themselves. The reason for this is that at low human and animal population densities support-area degradation occurs only very slowly and for any one generation has been almost imperceptible. Every generation thinks that their village support area always looks like they see it. Or, if they discern a decline during their lifetimes, they assume it is inevitable and do not see the implications of this decline or what might be done to reverse it - until recently. Another intrinsic factor contributing to support-area degradation is fire. Even occasional fires in the support area in the dry season are devastating to young tree growth. Most support-area fires result from human activities and there is usually a lack of organised effort to fight them. It should be noted that tree cutting per se does not cause tree cover to

thin, unless excessive; at sustainable levels of cutting natural regeneration maintains tree population – unless grazing is allowed or fire is not controlled. Tree cutting has sometimes been excessive, a topic we will return to later. The point here is that even if no trees are cut, grazing, above a very low threshold intensity, will eventually destroy a forest.

The original natural vegetation of the Indian subcontinent was broad-leaved forest. There is a wealth of archaeological evidence for this as well as written eyewitness reports, (see review by Erdosy, 1998). Today there is very little forest left anywhere. Overall agriculture is undoubtedly the main cause of deforestation, though since about 1800 colonialism and industrialisation have probably been the main causes. The process of deforestation in farmed areas of the Himalayas and the plains of U. P. during the period from approximately 3000 BC to 1800 AD is revealed by pollen studies and by a succession of eyewitness accounts (Erdosy, 1998). Changes in species composition occurred, such as, for example, a decline in oak (*Quercus* spp.) and an increase in *chir* pine (*Pinus roxburghii*) in the Himalayas. A general thinning of forests also occurred. These changes were brought about by clear-cutting to make fields for cultivation and by selective over-cutting, grazing by domestic animals and fire in the remaining forest surrounding villages.

This change in species composition is still proceeding in village forests in Uttarakhand. Oak is the more useful tree in the maintenance of an agricultural ecosystem, providing green leaves for fodder, dry leaves for making high-quality compost (after being used as animal bedding), small wood for farm implements and fuelwood. *Chir* pine provides stemwood (timber), fuelwood and resin (for sale). When oak trees are cut or die out they are not replaced by new seedlings as these are destroyed by grazing animals and fire. *Chir* pine is unpalatable to animals and relatively resistant to fire, and for these reasons gradually replaces oak. Oak-dominant forest is the climax vegetation of Uttarakhand in the altitude range of about 1500 to 3000 metres, which is the chief farming zone. *Chir* pine indicates a regression from the climax (see Box 2.1. Ecosystem regression in the Central Himalayas, see p 55).

In addition to deforestation, soil erosion indicates that traditional agriculture in India may not be sustainable in the long run. We all agree that high rates of

soil erosion indicate that a farming system is unsustainable. We also assume (or hope) that low rates are sustainable. But what are 'high' and 'low'? Can we define them quantitatively in any particular setting? If not, are we justified in assuming that any given level of soil erosion is acceptable? I will argue in Chapters 2 and 4 that a rate of soil erosion greater than that occurring in the original natural forest of the locality indicates unsustainability in the long run. If this argument be accepted, then traditional agriculture in India is unsustainable.

Degradation of village support area leads to a general decline in the productivity of the entire system. This process can be traced with the help of the diagram in Figure 1.1. The original forest cover in most of India is broad-leaved evergreen or deciduous. Many species in this forest provide high-quality cattle fodder in the form of lopped green tree leaves, and lopping is begun at an early stage of settlement because closed-canopy forest provides very little for animals to graze. Lopped fodder is fed at stall to supplement inadequate grazed fodder. Since there is a mix of species, lopped fodder is available fairly uniformly throughout the year. As the tree cover thins, the quantity of tree-leaf fodder decreases. This is partly compensated by the appearance of grasses which provide grazed fodder. But grasses in a forest climax zone produce annually less biomass per unit area of land than the intact forest cover (about 1/2 in Uttarakhand), and production is seasonal (grasses grow only during the monsoon season). Thus with the thinning of the support-area tree cover animal nutrition suffers. Nutritionally-poor cereal straws replace green tree-leaf fodder. Animal production becomes seasonal – good during the monsoon season when green grazed grass is available, poor the rest of the year. Moreover, continuous grazing causes regression of the grass cover; in Uttarakhand measured grass fodder production is commonly reduced by a factor of 5 (GBPUAT, 1982). At very advanced stages of degradation of the vegetative cover of the village support area, total animal numbers decline. The effects of these changes are a decrease in animal output (milk, draught power and dung). Crop yields decline from lack of manuring. Fuelwood availability declines with the disappearance of the tree cover, and dried animal dung substitutes for fuelwood, causing yet a further decline in crop yields. At advanced stages of degradation the land increasingly becomes bare giving rise to soil erosion which causes a permanent loss of productive capacity. On bare land water infiltration rate is reduced

causing a decrease in groundwater recharge. Virtually none of our land is today free from some degree of degradation, and much of it is at an advanced stage where original productive potential has been permanently impaired. Yet the natural regenerative capacity of even badly-degraded land is remarkable when improved, ecological management is practiced. Herein lies our hope for the future.

Ecological Poverty

The degradation of village land leads to what has recently been termed 'ecological poverty' (Aggarwal, 1998), but which was first described three decades ago by Sri Madhava Ashish (1978, 1979). This poverty results from shortages of basic life-supporting materials – food, fuel, fodder and water – and not from a shortage of money.[4] A clear understanding of this concept of ecological poverty is essential if what follows is to be intelligible.

In most rural areas, where there are only limited opportunities for money-earning employment in or near the village, a large proportion of a family's income is in the form of materials they produce on their own land (both on their own cultivated land and on the community-owned, village support area). Many of these materials do not have a money value, except in theory, because they are bulky, perishable and have no practical substitute; water, green fodder, fuelwood and dry-leaf animal bedding material are examples. They are needed daily by every family; if quantities produced fall below minimum requirements, deprivation (that is, poverty) occurs. In an environment of scarcity of these materials, even a family that has a good money income from paid employment suffers.

It is usually argued that in the present-day national/ global economy with its vast communications and transport networks substitutes can surely be provided. But consider: are governments ready to provide cooking gas to all of rural India, and water and green tree-leaf fodder? For the sake of argument let us say that it would be possible to do so. Rural people would still need the money with which to purchase these things. From where would that money come, given our centralised industrialisation model and globalisation agenda? And why should they spend money for things that they can produce for themselves?

The rural population has possession of, or the right to use, an invaluable national resource – land. Why should they not be expected (and, of course, wisely helped) to manage it for high and sustained production; why should the land be allowed to continue to deteriorate while the national economy struggles to provide for them from other sources? Will the present irrigated, green-revolution areas of the country continue to be able to feed urban India as well as the non-green-revolution rural areas? Green revolution farming is proving itself unsustainable, and even present yields are unlikely to be maintained. It is for these reasons that I argue that the main problem of rural India is ecological poverty - that is, shortages of locally-produced, basic life-supporting materials due to land degradation - and not primarily poverty due to a lack of money. And no amount of money pumped into rural areas as conventional 'development' or welfare can relieve ecological poverty. It must be tackled directly.

In the Western approach to development, which our policy makers have been quick to adopt, environmental concerns and poverty eradication are seen as antithetical. This has led to support for a policy of poverty eradication through an intensification of globalisation. This suits global business interests. The reality in rural India is that environmental degradation is the primary cause of poverty, even though, in their present disempowered state, rural people also contribute to further degradation. Examples of this are given later in this chapter and in Chapter 4 in describing the effects of government take-over of village forest. Industrialisation, furthered now as globalisation, has destroyed millions of non-farming or part-time non-farming traditional rural livelihoods, thus adding economic to ecological poverty.

The response

After decades of rapidly worsening environmental deterioration (that is, falling land productivity), ineffective government development programmes, and all-round modernisation, rural people in many parts of the country are seeking to solve the problem of poverty on their own. In the non-green-revolution areas women are generally taking the lead because they understand

better than men that their main problem is ecological poverty, and are focusing their attention on the rehabilitation of the village support area through community action. In the green-revolution areas individual families are pioneering organic farming on cultivated land badly damaged by chemicals (Alvares, 1999; Chapter 9). While this latter is a move in the right direction, it will not be feasible generally unless village support areas are rehabilitated, and in many cases expanded, to provide the inputs required for organic manuring; we will return to this point later.

In Uttarakhand numerous village women's groups have formed spontaneously or with a lead from local NGOs.[5] Three common features of all these groups are:

1. The women have given up hoping that the government or anyone else will solve the problem of their daily struggle to obtain fuelwood, fodder and water. They come together and formulate an agreed programme of work. Often, once they get going, their men begin lending support and practical help.

2. The groups are representative in membership and democratic in functioning. Usually every family in the village is represented by one member. Meetings are held periodically and conducted informally. Agreement is reached by consensus.

3. All families in the village share equally the work and expense of implementing their plans, and all share equally the fodder and fuelwood from the rehabilitated plots.

In addition to support-area rehabilitation (Figure 1.2) these women's groups run pre-school centres with environmentally-focused teaching/ learning programmes, rehabilitate traditional water sources, and construct sanitary latrines, petition (and even agitate) for improved government departmental services, and fight the problem of alcoholism among men. An example of one such village is given in Box 1.1.

This response, and similar responses of communities throughout the country (see review by Nadkarni, 2000), form the basis of an evolving alternative to

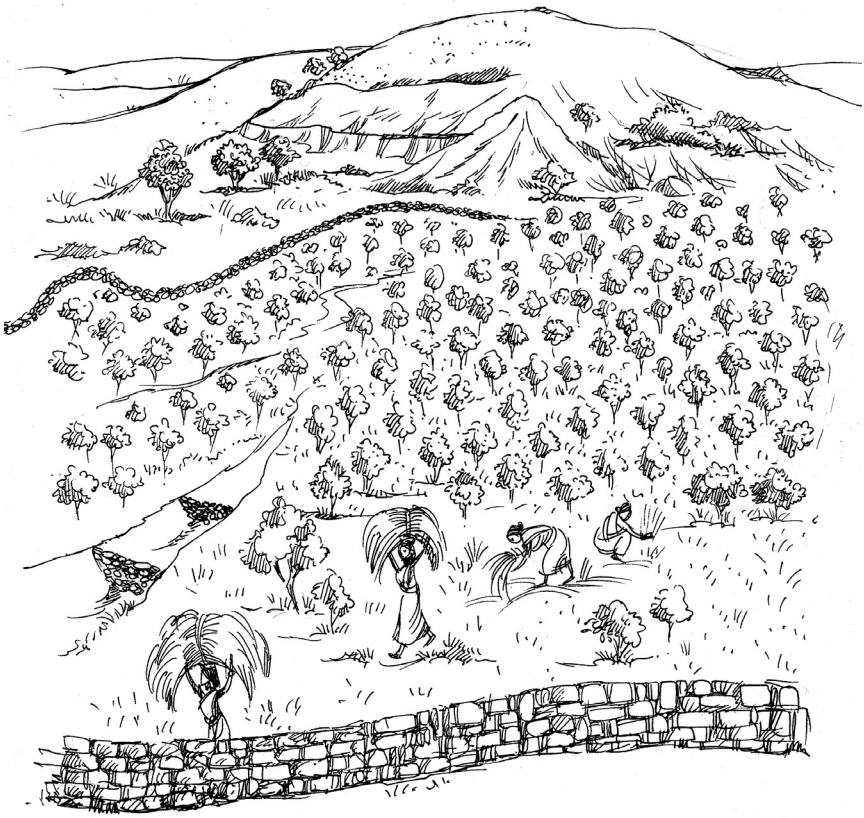


Figure 1.2. Badly degraded village community land being rehabilitated by community effort, Walling, gully plugging and tree planting have been done. Grass production increases markedly by the second year of protection from grazing and fire (see Box 2.1). Later, the trees will shade out the grass, but will produce even more fodder (and fodder of better quality) in the form of green tree leaves. Alternatively, the trees can be managed for fuelwood and stemwood production. In this picture, women are harvesting grass from among the growing trees. (Adapted from UEEC, 2008)

government and aid-agency 'development'. The vision implied, but as yet inadequately articulated, is of achieving ecological security by rehabilitating village land through collective self-help. Ecological security and a healthy community life are considered pre-requisites for economic betterment. Standard development programmes usually do not bring lasting benefits because they focus on family-scale, money-earning enterprises, neglecting community building and ecological security.

This alternative approach is tentative. These women's groups are very fragile. They often take a long time to form, and can easily be disrupted. They need the support, moral, technical and, to the extent possible, financial, of independent NGOs (that is, those NGOs that have not been co-opted by government and aid-agency development projects).

Government and aid-agency projects now-a-days generally stipulate the formation of 'user groups', or even whole-village groups, but such groups usually collapse after the project ends (see Mohanty, 2002, for a study of this problem). Conventional development (that is, money-driven development) activities of all kinds have conditioned rural people to look only for immediate personal monetary benefit, making the task of village empowerment more difficult. I know of examples of functioning village women's groups being destroyed by the coming of conventional aid projects.

The advent of revitalised village panchayats (elected village management committees with statutory duties and powers) in accordance with the directives of the 73rd and 74th Constitutional Amendments is giving rise to a major challenge to women's groups: how to introduce whole-village democratic governance to which they are committed into the panchayat form of representational governance. The Madhya Pradesh government has gone some way to meeting this challenge by making it mandatory for the gram sabha (whole village forum) to review all expenditures made by the Sarpanch (chief executive of the panchayat). Also, there are several planning committees of gram sabha members to ensure that all development funds are not spent on infrastructure projects, but allocated also to social programmes like health and education (Singh, 2001).

A village ecosystem model

In seeking to understand the traditional village system of settlement and land use more deeply and comprehensively an ecosystem model is helpful (GBPUAT, 1982; Jackson, 1985; Singh and Jackson, 1992; Jackson, et al., 1997; UEEC, 2008; Pande, 2004). This makes it possible to apply current ecological concepts in a coherent way. The model, when quantified, becomes a useful land-management tool.

The model was developed and tested in a particular setting, the villages of the mountainous region of Uttarakhand state in North India. The state is bordered by China (Tibet) in the North, Nepal in the East, Himachal Pradesh, another Himalayan state, to the West, and the Ganga plain to the South. Settled communities are found in the altitude range of approximately 700 to 3000 metres. Villages are small, usually not more than 50 to 100 families (250 to 500 people) occupying an average of 100-200 hectares of land. About one-half of this land is village forest, which is common land, the remaining being terraced cultivated land, roads and built-up areas. Cultivated land and domestic animals (about five cow equivalents per family)[6] are owned by individual families. In addition each village has access to specified government reserved forest areas from which they collect dry wood and dry leaves (for animal bedding). Water, from springs, seepages and streams, is a common village resource. Owing to extensive land degradation and rapid population increase, economic poverty forces many people, particularly men, to migrate to the plains to find paid employment. This leaves most of the household work, and that of producing crops and tending animals, to be done by women. A fuller description of these villages is given by Pande (2004). While these features are common to virtually all villages in India, population sizes, land areas, and water availability vary enormously from one region to another.

The diagram in Figure 1.1 may be taken as a simple ecosystem model. The outer line is the ecosystem boundary which coincides with the village geographical boundary. It encloses cultivated land, support area, roads, paths, rivers/ streams and built up sites, though in practice the model deals with only cultivated land and support area. The model is a partial energy-flow model; the arrows (except for those for water) represent annual flows of energy. The model is partial

Box 1.1.

The women of Shiling

Shiling village in Bhikiasen Block, District Almora, Uttarakhand has a total population of 603 out of which 325 people, mostly men, have migrated to cities in search of jobs. Women do all the farm work except ploughing. They also collect fuelwood, fodder, water, look after animals and rear children.

A *mahila mangal dal* (women's group) was formed in the village in 1996 after a series of meetings organised by The Society for Environmental Education and Rural Development (SEED), a local community based organisation. The women identified children's education, land degradation, deforestation, lack of safe drinking water and sanitation facilities, health and alcoholism among men as the main village problems. According to Mohan Kandpal, Secretary SEED, the women slowly realised that all these problems are interrelated and the negative environmental impact of one activity are magnified by those of the others.

In 1997 the women's group started to plant oak (*Quercus leucotrichophora*) seedlings in part of the village common land, after protecting it from grazing animals. Initially, 1000 seedlings were purchased from the Forest Department nursery. However, the Forest Department nursery raises mostly pine saplings whilst women wanted broad leaf species for fodder. In 1999 they started their own nursery to produce oak, *bhimal* (*Grewia optiva*), *kafal* (*Myrica nagi*), *kweral* (*Bauhinia purpurea*) and so on In 2001, the nursery sold 1200 surplus oak seedlings to nearby schools and other women's groups. The money was deposited in the women's fund.

By 2002 three hectares have been afforested with a survival rate of 70% for the new saplings. The women's group makes rules for the management of the plantation, implements them, and modifies them, as necessary.

With the help of men and boys in the village, infiltration pits, locally called chals, have been dug to increase groundwater recharge.

According to Heera Devi, president of the *mahila mangal dal*, alcoholism among unemployed men is due to frustration. This results in domestic violence. The women agreed to fight this problem. Now, any man found drunk, even on festive occasions such as weddings, are publicly censured and fined.

With the help of SEED a *balwadi* (pre-primary school) was started in the village. Environmental education is a part of the curriculum with several activities related to children's daily lives. Similarly, training camps on reproductive health are organised for adolescent girls.

Contd...

Mohan Kandpal's vision of rural development embraces improvements in the overall quality of life in the village. This vision stresses sustainable relationships between village resources, especially land and water, and village people. In this development process the community gains confidence and solidarity. The litmus test, however, is the number of young people who learn to value the work of their mothers and to see the possibilities of improving future village life.

(Source: Anuradha Pande, personnel communication)

because solar energy input and heat energy output are disregarded. Also disregarded are the flow of human energy (work) and the intangible flow of energy in the form of human management skill. The purpose for which the model was developed is not to aid precise scientific study, but to convey the ecosystem concept as applied to a village to adult village residents and to junior high school students in rural areas. (In respect of the latter, see Box 1.2, *Hamari Dharti, Hamara Jivan* (Our land, Our Life.) Market transactions across the village ecosystem boundary are ignored in the first instance, as is the question of the sanitary and effective recycling of human excreta.

The ecosystem concept allows one to see that the village with its land, animals and people, is a system. This leads to an understanding that the system as a whole is more important than any of its parts individually: how and to what extent a change in a part (for example, support-area degradation) affects the whole; and why the productivity of a part (for example, cultivated land) cannot be increased in the long run except in the context of overall system improvement. The ecosystem concept also allows other important ecological concepts to be deployed meaningfully to understand the current village situation. A few examples are:

1. Progression/ regression of plant communities in natural vegetative cover. A predictable process; external forces causing regression/ promoting progression identified; progressive/ regressive stage related to annual biomass production of an area; certain plants indicate regression, such as, in Uttarakhand, *chir* pine (*Pinus roxburghii*), lantana (*Lantana camera*), and cactus.

2. Species diversity and ecosystem health and productivity. This principle underlies the traditional practice of mixed cropping and mixed livestock species; it is to be observed in planning new support-area tree plantations.

3. Species adaptation explained in terms of ecosystem niches; why introduced species such as crossbred cattle and 'high yielding' grain crop varieties generally fail in the Uttarakhand hill village ecosystem.

4. Sustainability of biomass production explained in terms of ecosystem energy balance; traditional and modern management practices which lead to negative ecosystem energy (and mineral) balances like grazing and outward-sloping cultivated terraces identified; support-area rehabilitation and terrace remodelling lead to positive energy/ mineral balances; specified support-area tree-management practices, raising trees on terrace risers, and the collection of animal urine for use in composting, are examples of management practices that help ensure sustainability in rehabilitated village ecosystems.

5. The human community. The constraints of an ecosystem create a biological community, and the need to manage the village ecosystem collectively creates a community in spirit as well. In addition to support-area management, some communities are taking up village water management, and in fact water management is sometimes the starting point for community action rather than the support area. Community water management needs to be on the agenda of every village. In Uttarakhand the fragmentation of cultivated holdings makes it impossible to undertake terrace remodelling without first doing land consolidation; since government has been unwilling to do this in Uttarakhand, the village community itself must take the initiative.

6. Human health as a function of ecosystem health.

A complimentary concept to that of the village ecosystem, one that makes it practically operational, is the concept of ecosystem health (Jackson, 2004). It is based upon the notion that ecosystems are living beings and can thus get sick. To manage a village ecosystem effectively, a means to diagnose ill health is needed. Indicators of health (or otherwise) in this rural mountain setting are: volume and constancy of spring and stream flows, extent of soil erosion, degree of species diversity (in soil, in cultivated crops, in village forests and among domestic animals), and human population in relation to ecosystem carrying capacity. Measurable social indicators are human health (in particular the incidence of tuberculosis and nutritional deficiency diseases) and of personal

and social maladjustment such as alcoholism and domestic violence. The amount of leisure time women have is also an important indicator. No less important are un-measurable social indicators: feelings of well-being, security and community spirit.

The village ecosystem model as a land management tool

The village ecosystem model can be used to predict future outcomes of management decisions made in the present. For this it must be quantified.

Numerical values are determined for an individual village for the 12 parameters listed in Table 1.1. These are the most obvious features of the ecosystem, and those of most immediate everyday importance. Quantifying these parameters is kept simple, measurements being restricted to weighing with a portable spring balance, and for length and volume measurements a tape measure and a litre volume measure. Although notionally the model is an energy-flow model, for simplicity, flows are expressed in terms of air-dry weight for fodder, wood and food. Compost is expressed on a fresh basis as applied to the field. Milk and water are expressed in litres. Bullock draught power is expressed simply as the number of animal units of cattle. (Cattle numbers are generally a function of draught requirement; once this requirement is met, buffaloes are kept for milk production.) All family-related measurements/ enumerations (items 4 to 12 in Table 1.1) are done for a random sample of families. Land area figures are obtained from the village *patwari* (a government official responsible for maintaining land records) and, for government-owned parts of the village support area, the Forest Department. It was not found possible to measure stemwood consumption. Except for food purchases, market transactions are ignored. Measurements/enumerations are done periodically over a period of a year for items 4 to 12 in Table 1.1. Yearly average values are then calculated. These in turn (for items 4 and 7 to 12) are used to calculate total annual flow volumes. The most accurate figures are obtained from monthly measurements made one day every month for twelve consecutive months. Somewhat less accurate figures may be obtained from measurements/ enumerations made

Box 1.2.

Hamari Dharti, Hamara Jivan (Our Land, Our Life)

As elsewhere in India, the most pressing rural environmental problem in the mountainous region of Uttarakhand is land degradation, that is, the thinning of forest cover, soil erosion, and the drying up of natural water sources. The production of life-supporting materials like food, fodder, fuelwood is decreasing, and water scarcity is increasing due to inadequate groundwater recharge and excessive withdrawal. At the same time, human population is increasing rapidly. The general impact of modernisation, including school education, has alienated young people from the land; they all want well-paid jobs in the city and an urban, westernised life style.

In 1987 the Uttarakhand Environmental Education Centre, Almora, launched an environmental education course in government schools of the region to address these problems. The course deals with land and village forest rehabilitation and natural farming, and the importance of the community to achieve these. Students systematically study their local village ecosystem, learn traditional land, water and animal management techniques from village residents (that is, their own parents and neighbours – who are given legitimacy as teachers by the course), and learn to interpret all this information within a framework of current ecological concepts (that is, ecosystem, species diversity and adaptation, ecosystem health, ecosystem constraints, and carrying capacity). They also learn village land and water use planning through participatory, democratic community effort. Overall, an attempt is being made to foster the alternative view of a future of the village in which dignity, livelihood security and a modest standard of living can be achieved through local self-help effort.

The course is designed for grades 6, 7 and 8 and, after a testing and development phase of 20 years has now (in 2008) been formally incorporated into the Uttarakhand school curriculum which is followed in some 4000 schools. Details of the course, content, pedagogy, teacher orientation and follow up activities have been described by Pande (2001 a) and Jackson (2003 a). The latest version of the school workbooks (in Hindi and English) (UEEC, 2008) are available at www.ueec.org.in.

seasonally two or three times a year. The exact procedures developed for use in a school course Our Land, Our Life are described in detail in the students' workbooks for the course (UEEC, 2008).

To assess critically the possibilities of and limits to the village ecosystem model as a management tool, Pande (2004) studied a typical village in the

mountain region of Uttarakhand. The village was Maichun in Dhauladevi Block, Almora District. In addition to the parameters listed in Table 1.1, she also determined human population growth rate over the previous decade, and estimated support-area fuelwood production, and also experimented with more than one method of measurement/ estimation of a given parameter. She found that compost production and crop yield could not be reliably determined, given the constraints of the simple measurement techniques that are possible with this type of study.

The village has 74 ha. of common forest land, 60 ha. of cultivated fields and 10 ha. of other land. In addition, the residents of Maichun have access to government reserve forest land at some distance away from the village from which they obtain about three-fourths of their total fuelwood supply. One ha. cultivated land is irrigated from a stream. There are 56 families in the village with a total of 295 residents (89 people had migrated permanently or temporarily at the time of the study to find employment outside the village).

In Maichun, modern chemical inputs for crop production are not used, for reasons that are explained in Chapter 4. This means that crops depend entirely on farm compost.

As in most of the villages in this region, most of the village support area of Maichun was bare of trees. Moreover, the tree cover of the government reserve forest area from which most of the village fuelwood supply comes is also rapidly thinning. These two facts clearly indicate a fuelwood supply crisis in a few years time. The supply of tree-leaf fodder, which is critical to good animal nutrition during the long dry season, was also very inadequate. Recognising these facts, the village women's society had begun reforesting and protecting from gazing and fire a portion of the treeless support area one year before the study was done. The women intended to continue this work until the entire village support area was reforested.

An important management question arose: how much of the village support area would need to be put into fuelwood plantations (assuming supplies from the reserve forest would cease), how much to fodder and how much to stemwood (timber)? (The species composition and management systems differ for each

Table 1.1. Ecosystem parameters measured/ enumerated

	Parameter	Comment
1	Support-area land area	Classified according to soil depth, that is, productivity.*
2	Cultivated land area	Classified according to potential productivity as upland and bottom land
3	Water production	From springs, seepages and small streams; rivers are excluded
4	Human population	Total number of persons residing in the village
5	Animal population	Enumerated by species, adult and young
6	Food production	Cereals, pulses, vegetables and fruit
7	Milk production	Cow and buffalo
8	Compost production	Quality variable, depending upon moisture content and degree of decomposition
9	Consumption of dry leaves for animal bedding	Includes crop residues where these are also used
10	Consumption of fodder	From support area and cultivated land, both green and dry, grazed and hand-cut
11	Fuelwood consumption	Includes crop residues and dried dung where these are used
12	Water consumption	Domestic use and watering animals at stall

* Support-area land classes are: class I, soil depth more than 25 cm; class II, soil depth 10 -25 cm; class III, soil depth less than 10 cm. Most broad-leaved fodder type trees, like oak (*Quercus* spp.), only thrive on class I land, whereas *chir* pine (*Pinus roxburghii*), acacia (*Acacia* spp.) and robinia (*Robinia psuedoacacia*) can grow (albeit slowly) on class III land.

of these types of plantation.) Using data from the quantified village model it was possible to provide answers to these questions. These were 32, 21 and 21 ha., respectively. (Fuelwood is also obtained as a by-product of stemwood production - to the extent of some 40 percent of the total wood production

from a stemwood plantation.) Complete fuelwood needs could be met in perhaps 20 years time, and with sustainable management thereafter yields could be maintained more or less indefinitely.

In these calculations productivity figures from well-managed experimental stemwood plantations in different land class areas in government agricultural research institutes and Forest Department research stations were used to estimate future yields. Potential fuelwood and fodder yields were assumed to be equivalent to stemwood yields. Grass yield figures for village support areas not grazed and maintained only for dry grass production were used.

A major assumption in doing these calculations was that village population would increase over the next 20 years at the rate it had over the previous 20 years. Beyond that time, if population continued to increase, the carrying capacity of the ecosystem in terms of fuelwood supply would be exceeded and supply would fall behind demand. There is here clearly an incentive to stabilise population.

The quantified model is also useful in assessing water supplies and planning for the use of water surplus to domestic needs for irrigation. In those villages with valley-bottom land, such land is usually irrigated. However, small areas in upland fields can often be irrigated by gravity with surplus water from springs and seepages. Generally flows are small, and for effective irrigation, collection tanks must be built. Detailed water flow data from all springs and seepages can be used to calculate how much water can be collected, and hence what size tanks to construct, where to construct the tanks, how much area can be irrigated, and finally to set up irrigation timetables. In any given village a community planning exercise is necessary. Pande's study indicated a small surplus of water that might be used and its locations.

Rehabilitation of the village support area by planting trees would have several spin offs: an increase in total fodder, as well as in the proportion of green tree-leaf fodder; greater animal numbers and health, and so an increase in milk production; more compost of better quality and hence greater crop yields, as well as yields of crop residues which are used as animal fodder. More complete use of available water supplies would also boost crop production.

These effects can be expected in view of the inter-relationships depicted in the ecosystem model. The initial expectation of being able to estimate the magnitude of these increases could not, however, be realised in the Maichun study. As has been pointed out, current compost and crop production figures could not reliably be estimated, and any future estimates would have to be based upon these. Present estimates of milk production can reliably be made, and so can present and future support-area fodder production, but estimating future milk yields would require production functions relating milk yield to fodder input. Such functions do not exist for village conditions, and in view of the innumerable factors affecting milk yield aside from fodder quantity and quality, it is doubtful if any reliable functions could be developed.

Some further considerations

Energy security at the village level

Energy security in terms of meeting fuel requirements for cooking and heating from the village ecosystem was given priority in Pande's study of Maichun village. The rationale for this is that bottled gas is simply not an alternative for these rural areas. Distribution is a problem, but more important is the fact that world non-renewable energy resources are finite and that increasing the use of renewable energy is an important way in which to our nation can reduce its net production of greenhouse gases. Producing this energy locally on land that is producing well below its capacity, using local labour and thus avoiding out-of-pocket expenditure by village people for energy is the sensible option. This argument is further strengthened by the consideration that in the process further land degradation will be prevented.

In villages in the lowland plains, temperatures are high enough to make biogas production from animal and human excreta feasible, and, indeed, essential, but in most mountain villages gas production is severely limited by low temperature. And even in the plains, the technical and managerial problems of biogas production have not been overcome to any significant degree.

As a footnote to the mention of energy security in plains villages, biogas appears to be essential because there is, in general, a smaller proportion of

non-cropped land in these villages. Even then, however, the growing of more trees is vital to produce recyclable biomass to support crop production – assuming that the use of chemical fertilisers will have to be phased out in the long run to ensure sustainability. Considerable fuel wood will be a by-product of the growing of such trees.

Food security is, of course, also desirable at the local, village level. Today, virtually all villages in the mountain region of Uttarakhand depend upon market supplies of food for a substantial part of their requirements. More food will be produced as a result of village support-area rehabilitation, though in some cases, perhaps in most cases, village population has already exceeded the carrying capacity of the ecosystem, even when rehabilitated. This too, points to the desperate need for population stabilisation. By the term 'food security' adequate quantities of grains, pulses, vegetables, fruit and milk is meant.

Implications for school education

We are witnessing today the spontaneous innovation by rural people in the matter of land management techniques and community life. This augurs well for the future. Education could facilitate this trend, but the school syllabus would need to be different from the present centralised one with its modernisation orientation. This orientation is a reflection of the core values and perceived interests of the urban elite. The course initiated by the UEEC in Uttarakhand (Box 1.2, *Hamari Dharti, Hamara Jivan* [Our Land, Our Life]) shows that there is a felt need for change in rural areas, and that this need is beginning to be reflected in official school policy.

Considerable clarity on the issue of relevant rural school education could be achieved, in my opinion, by modifying the concept of an absolutely uniform national school curriculum and recognising that the educational needs of rural and urban people are different. This should not be taken to imply that I think that there are two mutually-exclusive Indias. There are two segments of a single nation. What is common to both and what is different? The concepts of the ecosystem and community could be foundational concepts in both urban and rural school curricula. This chapter describes how they can be

elaborated in a rural context; someone would need to elaborate them appropriately for an urban context. After all, it is of primary importance for all of us to live in harmony with the natural environment of our locality and with the other people of our locality. How we organise ourselves to do this, and what techniques we use, are details that will vary with the ecosystem and the community.

The matter of national development policy

Today young people have no incentive to stay in the village because it offers almost no economic opportunity. This is a country-wide problem resulting from the fact that in villages today traditional service and manufacturing enterprises have largely been destroyed, while all new ones have been created in urban areas. This is a feature of our post-independence industrialisation strategy. The rationale for it is to be found in the modernisation paradigm which requires efficiencies of scale and competitiveness in the world market. Thus the entire village community is now directly dependent upon the land, and the land, even when rehabilitated and sustainably managed, is insufficient. The re-creation of viable village communities will thus require, in addition to good land management, a reversal of our national development policy. Instead of seeking to accommodate ourselves to globalisation we would foster local food security, local markets, small scale, village-level service and manufacturing activities, local trade through barter or local currencies, all of which were a part of traditional rural life. This is a move that has been explored in considerable detail, both in India (Kothari, 1990) and in the West (Schumacher, 1974; Goldsmith, 1992). It constitutes what is being termed the 'localisation' agenda.

Population stabilisation

Even if programmes to achieve ecological and economic security are undertaken, there is a question mark over the future of many villages because population has already exceeded the potential carrying capacity of the village ecosystem. If economic opportunities are created at the village level as a result of national policy, it seems likely that many of the migrant men of such villages would want to return, increasing resident village population still more.

Even with population stabilisation, if many of the migrants from Maichun returned, the future would be uncertain. They are already dependent upon the market for a portion of their food, and would become so for fuel as well. Will there be food surplus producing areas in the country in the future? What arrangements can we make to ensure surpluses reach these villages? Our present public distribution system is failing, and is being dismantled. What about fuel supplies?

Empowerment

The ecosystem model of planning can obscure intra-village economic and social disparities – unless we specifically keep them in mind. Our guiding principles must be, as already suggested, equal participation of every member of the village in village ecosystem management, indeed in all aspects of community life, and an equal sharing of common ecosystem benefits. In the hill region of Uttarakhand, economic and social disparities are much less than elsewhere in the country; there is virtually no landlessness and in the women's groups there is typically equal participation of all caste groups of the village. Overcoming disparities must be an explicit feature of programmes for village community empowerment. Crude affirmative action projects targeting the less-well-off in a village render a holistic ecosystems approach impossible since this requires whole-community participation.

Government development funds now flow through village panchayats. The criteria for the appropriate use of such funds should be that it fosters ecologically-sound land management and that it strengthens the community in the first instance. These criteria are applied in an innovative programme pioneered by the UEEC in another of its programmes. Government funds (Ministry of Human Resources Development) made available to it are given in small grants to individual rural communities that have effectively organised themselves for projects that they have themselves devised and will themselves implement in their own villages. There are no strings attached to these grants, monitoring is informal and accounting procedures are simple. These grants are given on the basis of mutual trust and that trust has rarely been abused. Support-area rehabilitation projects are commonly proposed and funded. Such

projects are considered part of the learning process by which village communities develop the self-confidence and the competence to manage village land and water.

Land reforms

Land reform remains incomplete in many parts of the country, and must now be completed. Indeed, the land reforms agenda has now expanded to include not just the distribution of land in excess of ceilings to the landless, but also to landless women, and the recognition of tribal communities to manage, and profit from their ancestral lands (DN, 2002). It is difficult to visualise healthy village communities and sustainable agriculture where land reform is neglected.

The future of Maichun could be more secure if the large area of reserve forest to which they now have legal access was returned to village ownership and management. This land originally belonged to the village but was taken over by a colonial regime for commercial stemwood production. The public outcry when this was done forced the government to return this land to village use (with numerous rules and regulations) but not to village ownership. (This complex story with respect to Uttarakhand has been told by Guha, 1991.) Village people thus have rights to harvest biomass (fodder, dry leaves and dry wood) from this land but no duty to manage it. Moreover, the village is not legally recognised as a right holder, but only individuals within villages. This has introduced competition among individuals and a weakening of the village as a community, leading to over harvesting and loss of tree cover. And on those portions (that is, reserve forests) where government has reserved for itself the right of stemwood harvesting, over harvesting is the rule, and, because of village people's right to graze their animals, natural regeneration is blocked; hence the vast areas of treeless reserve forest land all over the country. The rehabilitation and subsequent sustainable management of this alienated land is far more likely to be assured if it were returned to village community ownership. Both individual village communities and the nation would benefit if this land is brought back into production. Nepal is showing

the direction in which we could move; the management and use of forest land there has been handed over to village communities, and the Forest Department has now only an advisory and facilitatory role. Further, in a number of instances in Nepal, and in China, upland communities are being paid for good-quality water supplied to lowland cities (See review by DN, 2002).

The restitution of reserve forest land to village ownership could be made conditional on population stabilisation. If this were not done, the village population would soon again exceed carrying capacity.

Agricultural research and education

We are seeing that virtually all the innovation for the realisation of an alternative future for rural India is coming from rural people themselves. If the real challenge for agriculture in the future is sustainable food production and viable rural communities, as I maintain, agricultural scientists should accept the research priorities being thrown up by rural innovations. This would require a complete reorientation of agricultural teaching and research, and the institutional structures in which they are pursued. A detailed consideration of this suggestion will be deferred to until Chapter 9 as a number of other issues must be explored first – such as an alternative science paradigm to support such an alternative orientation (Chapters 5 and 7), and the modes of education and research in traditional societies (Chapters 5, 7 and 8).

Notes

1. It is often supposed that the GR 'bypassed' areas of the country like the hill tracts of Uttarakhand. In fact government and NGO programmes both have attempted to popularise GR technology. Field demonstrations have been done, seed and chemical supplies organised. Farmers have tried this technology, and for the most part rejected it, as will be described in Chapter 4. Crossbred cattle in this region have been an even more spectacular failure than 'improved' crop varieties.

2. Watersheds (or, more accurately, water catchments) are widely used in land restoration projects in the country today. Their organising theme is water flow rather than, as in

the village ecosystem model, biomass flows. The latter are lost sight of in the watershed model. The management of watersheds is problematic because watershed boundaries usually do not coincide with village boundaries (Baviskar, 2003); indeed, most watersheds include more than one a village, and sometimes also parts of one or more villages. The village community is a more natural and effective social unit for land management than the watershed committee composed of members from a number of villages. Further, effective land management within individual villages in a watershed also conserves and regulates the flow of water in that watershed.

3. The true grassland biome is more or less absent in the Indian subcontinent. The climax vegetation everywhere, except for the Thar desert and the alpine grassland zone of the high Himalayas, is forest.

4. The results are poor health, hygiene, excessive work loads for women because men leave the village in search of paid work, and the low enrolment of girl children in school (Pande, 2001 b).

5. About 350 village Women's Groups have formed in Uttarakhand in association with UEEC and its network of local NGOs in the past 15 years. They have now come together to form a state-wide confederation.

6. A 'cow-equivalent' is one adult cow or bullock. An adult buffalo equals two cow equivalents. Five adult goats equals one cow equivalent. The young of any of these is considered, on average, to be one-half the adult value.

2

The Way Nature Farms

The hallmark of modern industrial, chemical agriculture is an attempt to manipulate and control natural processes. The rationale for this is the European Enlightenment belief in the possibility of dominating nature, even of re-creating it. The adverse 'side effects' of this type of farming[1] indicate that it cannot long continue. This has led a number of farmers and scientists to consider the possibility of gentler and thus more sustainable alternatives. Natural farming is one of these.

In natural farming an attempt is made to understand natural processes and then to devise ways of channelling these gently to meet our legitimate needs. We focus on groups of processes as whole, that is, on systems. These systems can be conceived of as living entities that can be successfully managed only if their tolerance limits are respected and if we strive to ensure their continued good health. In the case of an ecosystem, this means adapting to our local ecosystem rather than manipulating selected processes within it. We accommodate ourselves to nature, rather than trying to dominate her. Learning about systems and managing them effectively can best be accomplished by entering into them, by seeing ourselves as a part of them, and not by analysing them from the outside.

There is infinite variety in natural farming systems, as is to be expected where one seeks to adapt to one's local ecosystem. Detailed prescriptions are thus inappropriate. Further no natural farming system is a finished product, but a continuously evolving, dynamic entity; to be successful, the natural farmer must never stop learning and experimenting. The most that seems possible is to recognise a few very general principles, such as pioneers like Albert Howard and Masanobu Fukuoka have articulated.

Albert Howard's 'Nature's farming'

More than sixty years ago Albert Howard[2] made a case for what he termed "Nature's farming" (Howard, 1940). He reasoned that, as natural ecosystems are stable over long periods of time, to achieve stability in our farming systems we should imitate as far as possible the original, natural ecosystem of the particular locality where we farm. He drew our attention to four principles that he perceived to be operative in such systems, using a forest as an example. These were, in his own words (pp. 1-4):

1. Mixed cropping is the rule;
2. The soil is always protected from the direct action of sun, rain and wind;
3. The forest manures itself;
4. Crops and livestock look after themselves.

In the terminology of ecology, a science that developed largely after Howard's time, these four principles can be reworded to:

1. Maximum biodiversity;
2. Continuous soil cover; (Exposure of the soil surface to rain, sun and wind causes deterioration through rapid oxidation of soil humus, loss of biological activity, leaching of soluble minerals and soil erosion. In the tropics and in mountainous terrain these processes occur more rapidly than in temperate and lowland areas. Laterite soils also go hard when exposed. Soil loss

from water erosion can serve as a convenient index of soil deterioration in general.)

3. Complete circularity in the flows of biomass, energy and minerals within the ecosystem;

4. Adaptation of species to the local ecosystem to ensure maximum, sustainable biomass production. Adapted species, and mixtures of species, possess the maximum possible resistance to diseases and pests.

An understanding of these principles will be easier if they are seen in relation to the pattern of ecosystem evolution. As a natural ecosystem matures, or evolves, it displays an increasing complexity and stability until it reaches an adult or 'climax' stage. Thus for a given ecosystem, biodiversity (both in the soil and in the above-ground flora and fauna) is maximum at the climax stage. Biomass production (that is, the annual production of primary, plant biomass in terms of tonnes of dry matter per ha.) is also maximum, and year-to-year fluctuations in production are minimum. Ground cover is complete in a mature ecosystem (closed tree canopy, undergrowth and a ground mat of decaying organic matter) and therefore the rate of soil loss through erosion is less than the rate of soil formation (or deposition), resulting in a gradual increase in soil depth.. During the maturation process an ecosystem builds up in carbon content (in both the soil and in above-ground biomass) to a state of equilibrium in which carbon loss in respiration is balanced by carbon gain from photosynthesis.

Individual species evolve along with the ecosystem of which they are a part, until at ecosystem maturity each is adapted to the conditions of the system and each contributes something vital and unique to the structure and functioning of the system. A mature ecosystem shows a high degree of resistance to the invasion of foreign species or varieties.

If a mature ecosystem is interfered with by human beings it regresses. With regression there is a loss of complexity and stability. Biomass productivity declines, carbon balance turns negative and soil erosion may accelerate. Owing to the changed conditions, foreign species or varieties more easily invade the

Box 2.1.

Ecosystem regression in the Central Himalayas

Observational data from the Central Himalayas illustrate some of the features of ecosystem maturation, regression and subsequent recovery (VRIHA, 1988). Various parts of a continuously-grazed slope near Almora in Uttarakhand, bare of all trees and shrubs had been enclosed at different times in the past and so protected from grazing animals. Subsequent to closure, grass was hand-cut once a year at maturity (after the monsoon season) in the protected plots, while in the 'open' area temporary wire enclosures were presumably made within which frequent hand-harvesting to simulate continuous grazing was done during the monsoon season. The yields of grass on a dry-weight basis were determined and plant species enumerated. The data for 1981 were as follows:

Plot	Dry grass production, $t\ ha^{-1}\ yr^{-1}$	Number of species of plants present
No protection	0.97	13
Two years protection	3.83	22
Five years protection	4.43	26
Long-term protection	5.61	38

The natural vegetation of this slope had been mixed broad-leaved oak-dominated forest. Cutting, animal grazing and probably fire had caused it to regress to grassland, and to very degraded grassland at that. Enclosure and controlled harvesting allowed the vegetative cover to begin to regenerate. Species diversity increased as did biomass production. Had the area been left undisturbed, shrubs and eventually trees would have appeared; the annual grass cutting stopped the progression at the grass stage.

Chir pine (*Pinus roxburghii*) is an invasive species in degraded oak-climax forest in this region (Chapter 1). With severe degradation, as in this case, even chir pine disappears.

ecosystem, establish themselves and bring about further changes in the system. (Box 2.1)

Thus when farming is taken up in a previously undisturbed, mature ecosystem it inevitably degrades the system. This degradation is the price to be paid for

an increase in the proportion of the total ecosystem biomass production that can serve direct human needs (for example, more food, less wood). However, a farmed ecosystem can in theory be stabilised at an intermediate stage; it need not continue to degrade further after the original settlement. To achieve this requires knowledge, skill and constant effort on the part of the people of the farming community. They must understand and preserve/ imitate the essential features of the intact mature ecosystem. If they succeed, they produce sufficient quantities of biomass of all the types they need while preserving sufficient biodiversity to buffer the system, ensuring continuous soil cover and maintaining circularity (that is, the recycling of all organic matter to ensure that the carbon content of the system does not decline). They are circumspect about introducing foreign species or varieties into their farming system.

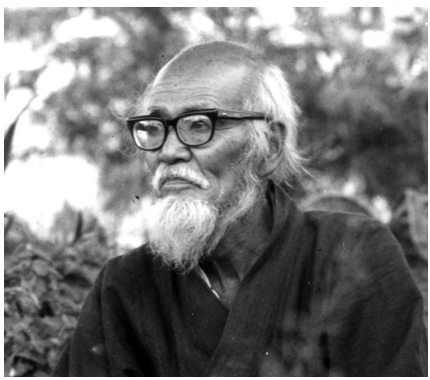
Two features of nature's farming, when successfully practised, need to be emphasised. First, there is always a large reserve of available mineral elements in the system and hence special attention to 'the maintenance of soil fertility' is unnecessary. This reserve is present in both the soil and in above-ground living organisms. In tropical forest ecosystems most of it is present above ground, since minerals released by decomposing forest litter are largely taken up by the surface-growing root mat and do not enter the soil to any great extent. In temperate forest ecosystems most of it is present in soil humus and decaying litter on the soil surface. Minerals in humus and living organisms are not immediately available as are those in soil solution or in exchangeable form on soil particles, but become available slowly during the course of the year with the mediation of soil organisms (that is, bacteria, fungi, mycorrhiza, earthworms, termites, and so on).

Second, crops and domestic animals really do 'look after themselves'. They remain largely free from grossly-feeding parasites and diseases. In fact, as Howard demonstrated in the field, the modern concepts of 'pests' and 'diseases' find no place in Nature's farming (Howard, 1940). Nothing, in the long run, can be gained by taking specific actions against any of the organisms present in the ecosystem (whether in cropped field, village forest or domestic animals),

but much might be lost by upsetting the delicate balance among species/ communities. The experience of introducing chemical pesticides into previously more-or-less stable traditional agricultural ecosystems has provided ample evidence of this, as even school textbooks now describe in considerable detail (NCERT, 1989).

Masanobu Fukuoka's 'natural farming'

Masanobu Fukuoka in Japan trained, and practised for a while, as an agricultural scientist, but deep reflection on the course of modern agriculture led him to the conviction that man can never understand nature by the analytical approach of modern science (Fukuoka, 1994). True understanding in his view is an intuitive process; nature is understood, if at all, only as a whole. Individual objects and processes seen in isolation from the whole of which they are parts are not real things. The technological innovations designed to manipulate these 'unreal' parts disrupt nature. They also create needless expense and work for the farmer; nature is quite able to farm on her own – if only we do not interfere.



Out of his experience of long years of experimentation on his own farm[3] Fukuoka has formulated the following four principles of natural farming.

The first is NO CULTIVATION, that is, no ploughing or turning the soil. For centuries, farmers have assumed that the plough is essential for growing crops. However, non-cultivation is fundamental to natural farming. The earth cultivates itself naturally by means of the penetration of plant roots and the activities of micro-organisms, small animals, and earthworms.

The second is NO CHEMICAL FERTILISER OR PREPARED COMPOST. People interfere with nature, and, try as they may, they cannot heal the resulting wounds.

Their careless farming practices drain the soil of essential nutrients. If left to itself, the soil maintains its fertility naturally, in accordance with the orderly cycle of plant and animal life.

The third is NO WEEDING BY TILLAGE OR HERBICIDES. Weeds play their part in building soil fertility and in balancing the biological community. As a fundamental principle, weeds should be controlled, not eliminated. Straw mulch, a ground cover of white clover inter-planted with the crops, and temporary flooding (in paddy) provide effective weed control in my fields.

The fourth is NO DEPENDENCE ON CHEMICALS. From the time that weak plants developed as a result of such unnatural practices as ploughing and fertilising, disease and insect imbalance became a great problem in agriculture. Nature, left alone, is in perfect balance. Harmful insects and plant diseases are always present, but do not occur in nature to an extent which requires the use of poisonous chemicals. The sensible approach to disease and insect control is to grow sturdy crops in a healthy environment.

(Fukuoka, 1994, pp. 33-4)

The similarities between Howard's and Fukuoka's approaches are evident. The only dissimilarity is on the issue of compost making. It must be remembered that Fukuoka lived in Japan where cereal straws are not needed to feed large ruminants and can be spread as mulch which subsequently turns into compost in the field, whereas Howard worked in India where all cereal straws are fed to animals and the resulting dung is used as manure after composting. Though important from a practical point of view, there is no difference in principle.

Though both Howard's and Fukuoka's sets of principles are essentially the same, we will, for convenience, define natural farming in terms of Howard's four principles as rendered in the ecological terminology suggested in the previous section.

Three further principles of natural farming

Both Howard and Fukuoka focused on the cropped field, treating it as an ecosystem. This is good as far as it goes, but is an inadequate perspective

from which to obtain a full description of natural farming. The individual field is embedded in a village ecosystem (Chapter 1), of which the human community is recognised as an essential component. The village is embedded in a region with its distinctive topography, soil types, weather patterns, and administrative and economic systems. In a country as vast and varied as ours, there are many such regions comprising a larger national context. A complete description of natural farming is possible only when all these larger contexts are taken into account.

The dangers of cash cropping

It will have been noticed that a fifth principle of natural farming was implied in discussing Howard's list: the farming system must produce 'sufficient biomass of all the types farmers need'. In the conditions of the modern world a surplus of some form(s) of biomass must be produced to trade in the market. However, if this becomes a major consideration the sustainability of the system will probably be lost, if the history of forced cash cropping in Africa and Asia under colonialism is recalled (see, for example, Mann, 1987), and the current trends towards globalisation are correctly understood (Hines and Dinham, 1984; Pereira, 1993; Watkins, 1996). Farming communities are compelled to take up cash cropping by the imperatives of national and global markets. They are dependent upon the market for farming inputs and for the sale of their produce. Both input and produce prices are subject to fluctuations in world markets and government policies (for example, by support prices). With the advent of contract farming people further lose control of their farming systems.

Monoculture cash cropping reduces sustainability in at least three ways. First, there is a reduction in ecosystem biodiversity when large areas are planted to a single crop, not to mention a single variety of a particular crop. Moreover, the variety of crop is usually specified by the buyer and is not adapted to the local ecosystem, or to any local ecosystem for that matter, having been bred for adaptability to the artificial environment of the research station; for them to succeed at all, the local ecosystem must be modified

drastically by the use of chemical pesticides and fertilisers. This move further reduces biodiversity.

Second, with cash cropping circularity is broken. Large quantities of biomass flow out of the local farming system to distant markets, while there are no mechanisms for the return of organic matter in the form of composted urban wastes.

Third, the excessive diversion of crop land to cash crops for export results in a loss of local and national food self sufficiency. In times of crisis, such as caused by drought or by the imposition of 'structural adjustments' by world financial institutions, farmers and nations are subjected to yet further domination of their farming by multinational corporations. The recent famine in Ethiopia is a grim example of this (Chossudovsky, 2000).

Population control

Whether or not a given farming ecosystem can produce 'sufficient quantities of biomass of all the types farmers need' depends also upon the number of people there are in the community to consume it. It is thus being proposed that yet another principle of natural farming is the ability of the community practising it to limit its size to the carrying capacity of the ecosystem. In uninhabited (by human beings) natural ecosystems the chief means by which the size of the population of any species is kept within the carrying capacity of the ecosystem is food supply. Natural regulation, of course, involves at times some malnutrition, starvation and premature death. To avoid this mechanism from coming into operation in human communities requires explicit control by the community of its reproductive rate. The need to face this fact has (till now) been evaded by most communities by opting for the alternative of migration. When that has not been possible, communities have intensified food production from their existing local ecosystem. But this has usually caused further ecosystem degradation; it also leads to an impoverishment of the people's diet (Waddell, 1977). There are, however, some traditional communities in which people are aware that the boundaries of their ecosystem are fixed, that there is nowhere to migrate to, and who wish to maintain their current lifestyle. They limit their

reproductive rate. In their worldviews human beings are a component of the ecosystem and their relationship to it is conceived of quantitatively, that is, they know roughly the human carrying capacity of their ecosystem. These conceptions are embodied in myth and ritual, and in practical rules that govern reproductive behaviour as well as resource utilisation. One carefully documented example is the Turkano people of the Amazon rainforest, a community subsisting largely on hunting and gathering, but also practising cultivation on a limited scale (Tolbert, 1998). Another is the Tsembaga community of *jhum* cultivators in New Guinea (Rappaport, 1976).

The idea that local, national and global ecosystems have a finite human carrying capacity is not a popular one today. We prefer the idea that economic growth and development, powered by modern science, technology and free trade will generate unlimited opportunities. The reality is far different as revealed in undeniable trends that will lead to world food shortage in a very few years (falling cropland available per capita, deforestation, water shortage, and the degradation of agricultural ecosystems) (Brown, 1994, 1998). In Chapter 1 the inescapable need for individual villages in a non-green revolution area of India to stabilise their populations has been shown. Similar carrying capacity exercises for villages in green revolution areas after rehabilitation and conversion to natural farming would probably reveal the same need for population stabilisation there as well. (This is not to be taken as meaning that there is a decrease in food production under natural farming as compared with green revolution farming; quite the opposite is usually the case, as will be shown in Chapter 9.)

Stable rural communities

One further principle, probably the most important, will round off our list. Sustainable agriculture can be carried on only by stable communities; that is, by communities possessing a coherent world view that embodies an ecological perspective.[4] Such a worldview gives every individual a sense of his or her place in the community, in nature and in the cosmos. It manifests in self-imposed restrictions governing behaviour towards other people and the environment. Traditional worldviews that have proved their worth in this respect

are today under attack everywhere by the powerful global community whose worldview (atomistic, mechanistic materialism) sanctions competitiveness, greed and aggression. It is this worldview that is the cause of unsustainable contemporary scientific agriculture. The power of this view is seemingly overwhelming; if it succeeds in destroying traditional organic, holistic worldviews altogether, and of stifling current initiatives to formulate more ecological, post-modern worldviews, sustainable agriculture will be impossible to achieve in the future. Our principle here for natural farming is therefore the existence of a cohesive community (self) governed by a coherent ecologically-oriented worldview.

Criteria of sustainability

The seven principles of natural farming outlined in this chapter may also be used as sustainability criteria to evaluate traditional and contemporary farming systems. In Chapter 3, they will be so used to evaluate traditional *jhum* cultivation, traditional sedentary Indian agriculture and modern chemical farming.

Some writers appear to assume that long-continuing farming systems, such as *jhum* and settled Indian systems, are sustainable simply because they are long-continuing. This view has been challenged in Chapters 1, 3 and 8; these systems are certainly superior to many which have perished, and deserve our close study, but there is ample evidence that they have deteriorated over time, even before the advent of modern agriculture. Persistence should thus not be used as a criterion of sustainability.

Notes

1. The adverse effects of chemical fertiliser and pesticide use in India and elsewhere have been extensively documented (Bose, 2000; Dasgupta, 2000; Goldsmith, 2000 b; Gorelick, 2000; Norberg-Hodge et al., 2001; Shiva, 1992; Third World Network, 1994). They include deterioration in soil biodiversity, increased rainwater runoff and soil erosion, toxic chemicals (for example, nitrates and pesticide residues) in groundwater and foods, and indebtedness, loss of land ownership and suicide among farmers. The high energy costs of fertiliser manufacture and transport and

the pollution these cause may be added to this list, as well as the depletion of mineral reserves. Chemical fertiliser use also encourages inefficient water utilisation with falling water tables at places and waterlogging and salinisation at others.

2. Albert Howard worked in India during the first four decades of the 20th century at Pusa, Indore and Quetta. When he took up the position of Economic Botanist at Pusa in 1905 he observed that: 'The crops grown by the cultivators in the neighbourhood...were remarkably free from pests of all kinds.... I decided that I could not do better than watch the operations of these peasants, and acquire their traditional knowledge as rapidly as possible. For the time being, therefore, I regarded them as my professors of agriculture. Another group of instructors were obviously the insects and fungi themselves. The methods of the cultivators if followed would result in crops practically free from disease; the insects and fungi would be useful for pointing out unsuitable varieties and methods of farming inappropriate to the locality (Howard, 1940, pp. 164).'

3. He has developed a system of growing paddy and winter cereals (wheat and barley) in rotation with irrigation on bottom land without ploughing, weeding or chemicals (Fukuoka, 1994). Weeds are controlled by sown leguminous under-crops and periodic flooding (in the paddy). Seed, enclosed in clay pellets, is broadcast onto a standing crop shortly before that crop is harvested. The (long) straw and husk from that crop is subsequently spread on the field. A little chicken manure is spread on the fields along with the straw. Labour requirement is low; Fukuoka terms his system 'do nothing farming'. Two preliminary experiments on this general method of field cropping have been undertaken in India, one by an NGO (Aggarwal, 1994) and the other by a farmer (Gandhi Peace Foundation and Indian Institute of Technology, Delhi, 1993), both under irrigated conditions. Evans in Nepal is also seeking to adapt Fukuoka's method to situations of limited irrigation (Evans, 2000).

4. When I say that traditional societies possessed an 'ecological perspective', I do not mean that they understood nature in terms of our present-day ecological concepts. Their worldviews contained equally potent ideas. They saw themselves as a part of nature. Everything in nature was considered sacred and interconnected. They expressed these feeling-ideas spontaneously by reverencing and protecting all forms of life (Chapters 5 and 8). The result was that, in general, they obtained their legitimate needs with a minimum disruption of the natural world.

3

Another Look at *Jhum* Cultivation

Many recent writers have taken a dismissive view of *jhum* cultivation (shifting cultivation, swidden).[1] Medhi and Sarma (2000) claim that 'eco-agriculturists' consider that *jhum* cultivation in North-eastern India is environmentally destructive and suggest that it be replaced by rubber plantations managed on the basis of modern scientific knowledge. Chandra (2000) has put forward the hypothesis that *jhum* cultivation is a precursor of later, more advanced forms of farming. It is the task of agricultural scientist, therefore, to introduce *jhum* cultivators to advanced farming techniques that will transform their 'primitive subsistence economy' to a 'surplus economy'. Sharma and Sharma (2000), consider the system of *jhum* cultivation practised by the Lakhers of Mizoram in Northeast India to be 'reasonably productive and sustainable'. All the same, they considered it to be 'primitive' and in need of 'modern interventions'.

None of these writers has, however, taken into account the fact of the sheer persistence of *jhum* cultivation. It is known definitely to have been practised continuously to the present (where not disrupted by outside influences) in the same areas of Sarawak (Malaysia) for three centuries (Hong, 1994). Randhawa (1980, pp. 263) infers from circumstantial evidence that *jhum* cultivation must have

been prevalent in the hills of Northeast India in Neolithic times (that is, about 4000 years ago). According to Sharma and Sharma (2000) themselves, the Lakhers of Mizoram have been practising *jhum* cultivation in the same area for nearly 1000 years, having migrated there from the Chin hills of Myanmar.

In contrast to this obvious persistence of *jhum* cultivation we need to remind ourselves that many 'technically advanced' sedentary farming systems have destroyed their local environment and perished along with the societies that practised them. One is thinking here of Roman agriculture which collapsed after a few centuries, having turned north Africa into a desert and much of Southern Italy into uncultivatable wasteland (Box 3.1). The 'dust bowl' of the USA in the 1930s was created in only half a century. Contemporary chemical agriculture is proving itself environmentally destructive and unlikely to persist (Third World Network, 1994). This is most evident in the tropics and subtropics; in India alarming environmental deterioration has become evident in a mere 20 years (Shiva, 1992; Dasgupta, 2000), and in Ghana and The Gambia in Africa on laterite soils, 4-5 years has been found to be the limit for cultivation (ploughing and mono-cropping with chemicals) of newly-cleared virgin jungle sites (Mann, 1987). In terms of persistence, therefore, *jhum* cultivation appears to be superior to many systems of sedentary agriculture, both ancient and modern.

In the Peruvian Andes the traditional farmers of a single village have different farming systems to suit the varied topography of their land. In valley bottoms they have permanent cultivated fields, on gentler slopes permanent terraces and on the steeper slopes they practice *jhum* cultivation (Berry, 1999 a). The Soras of Odisha practice field cultivation in the valleys and *jhum* cultivation on the surrounding slopes (Vitebsky, 1998). The farming practices of these communities seem to rebut the argument of Chandra (2000) that *jhum* cultivation persists only because knowledge of more 'advanced' farming techniques does not reach remote *jhum*-cultivating communities. Also, Sharma and Sharma (2000), quoting Levin (1870), have written that the Lakhers are acquainted with the technique of permanent terrace cultivation involving ploughing or digging practised elsewhere in the Himalayas. In spite of this they persist in their *jhum* cultivation.

Box 3.1.

Roman agriculture

Goldsmith (1992) has reviewed the decline and fall of the Roman Empire from a broad ecological point of view. Extensive deforestation and soil erosion are established facts. It is impossible to say exactly how much of this was due to agriculture; the need for wood for urban construction and shipbuilding was clearly a contributing factor. During the period of the Republic farming was done by communities of small-holder farm families who, by all accounts, were remarkably good farmers. However, during the period of the Empire, as the entire society and economy decayed, these farming communities were replaced by large private landholdings farmed by slave labour. This development appears to have greatly accelerated environmental degradation and decline in crop yields. Goldsmith ends his review by pointing out how modern Western, large-scale farming resembles agriculture in the latter days of the Roman Empire; in place of slaves, machines are now used.

According to Hillel (1991, pp. 105-6), the Romans '...fundamental belief was that the earth and everything on it or in it was meant for human use. In the short run, this attitude seemed practical and led the Romans from success to success, an experience that bolstered their sense of superiority....' Soon they began to notice, however, '...that their soil was becoming less fertile than it had been. Far from attributing this decline to mismanagement, they adopted the belief that the world as a whole was growing old and feeble, and that only vigorous human intervention could maintain it. This belief was expressed by some of the most prominent thinkers, including Virgil, Ovid and Seneca. Cicero, for one, heaped lavish praise upon human cleverness at manipulating nature in the areas of agriculture, mining, construction, water supplies and navigation. In his words, "By means of our hands we endeavoured to create as it were a second world within the world of nature." Seneca, too held that human efforts make the world more beautiful and useful. Pliny the Elder, however, and the wise agriculturalist Columella, ascribed the declining fertility of the earth to poor husbandry.'

Increasing numbers of people today are becoming interested in traditional agricultural systems because they are perceived as sustainable, or at least as more sustainable than contemporary scientific agriculture. This perception is based on the observation that many traditional systems have demonstrated their ability to support the communities which practise them over long periods of time; for, as the trustees of the Agri-History Foundation express it, the

South and South-eastern Asian region has '...generally provided food security to its population for several millennia...' (Asian Agri-History Journal in a statement of the aims of the Foundation). In view of this interest, *jhum* cultivation certainly deserves our open-minded, though critical appraisal – as deserving as any of the sedentary systems of the region. I use the term 'open-minded' because we must be prepared to forgo the use of our usual criteria in assessing farming systems, criteria, that is, derived from present-day mechanised, chemical agriculture, and use instead criteria that measure sustainability. Modern agriculture is 'scientific', 'productive', 'efficient', 'profitable', 'responsive to market demands', etc. - but, it is unsustainable. Sustainability criteria, on the other hand, derive from ecological theory and from concepts of local community, cultural and economic diversity and social justice. In Chapter 2 a set of seven such criteria have been described.[2] They will be used here to evaluate *jhum* cultivation.

Evaluation

Biodiversity

Cutting the forest in *jhum* fields and the subsequent burning cause a drastic local reduction in biodiversity of the general forest ecosystem. During the recovery phase, that is, after cultivation is abandoned (usually after two years), the vegetation evolves towards the original climax condition. It is assumed by many writers that if full recovery is achieved before the area is again cultivated, the system is entirely sustainable. This may be so, but there is no empirical proof. A closed tree canopy is re-established in a few years, but the return of the full climax community is probably, in most cases, not achieved before the area is again cleared, even with long *jhum* cycles. Rappaport (1976) observed (in New Guinea) that on *jhum* sites abandoned four years earlier, of the 36 species of tree present, 18 were part of the climax association found in the nearby areas of virgin forest. In a field abandoned 20-25 years earlier, 18 out of 26 species present were climax species. With a *jhum* cycle of less than 30 years in that locality, full recovery to the climax stage, as measured in these terms, is probably not achieved. However, the benefits of the climax vegetation are obtained in large measure in less than that period of time. Thus in the practical management of the forest ecosystem the Maring

people of this area (altitude range 600 to 2000 m) return to a previously-cultivated area when: 1) the trunk diameter of trees reaches 30 cm; 2) tree canopy is closed; and 3) the soil is soft. These conditions are met in 8 to 40 years depending upon altitude. Until mid-twentieth century *jhum* cycles in most areas were probably determined by practical criteria such as these, and even though full recovery was probably not the rule, the system continued satisfactorily, in terms of adequate food production, over long periods of time, as we have noted.

In North-eastern India Tokay and Ramakrishnan (1983) studied the changes with time in the vegetation of abandoned *jhum* fields. During the first five years species diversity remained low and plots were dominated by herbaceous species. Between 5 and 15 years after abandonment diversity increased rapidly as the vegetation passed into bamboo *(Dendroclamus hamiltonii)*-dominated forest. Still later it gradually passed into a mixed broad-leaved forest approaching the climax type, as judged by comparison of species composition with that of sacred groves in the locality. They did not follow the process beyond twenty years. Paralleling the increase in biodiversity, they found a steady increase in annual above-ground biomass production and accumulation (Table 3.1). Presumably below-ground biomass increased proportionately.

Table 3.1. Rates of biomass accumulation, litter fall, net primary productivity and standing biomass of forest regenerating after *jhum* cultivation in Meghalaya, North-eastern India (from Tokay and Ramakrishnan, 1983)

Attribute	Year 1	Year 5	Year 10	Year 15	Year 20
Accumulation in bole and branches, t ha^{-1} $year^{-1}$	4	4	7	9	8
Litter fall, t ha^{-1} $year^{-1}$	1	4	7	8	10
Net primary production, t ha^{-1} $year^{-1}$	5	8	14	17	18
Standing biomass, t ha^{-1}	5	23	57	103	150

The rapid recovery of abandoned *jhum* sites is facilitated by the presence of virgin forest in the locality, for, according to Hong (1994)[3], in Southeast Asia in areas with even long histories of *jhum* cultivation, some of the original climax forest has not been cleared even once. *Jhum* cultivators were found to prefer clearing previously-cultivated areas rather than virgin forest (it is easier), and in many areas very little virgin forest was being cleared. (The reports reviewed by Hong were of studies conducted before 1969.) In North-eastern India numerous sacred groves, already mentioned, undoubtedly serve as a source of seed that facilitates the recovery of abandoned *jhum* sites.

Also, incomplete clearing of *jhum* sites hastens subsequent forest recovery (Rappaport, 1976). Large trees are usually pollarded. Further, tree seedlings coming up among the sown crops are not removed during weeding. Herbaceous forest species, if they come up, are also not removed.

In cleared sites a great variety of food crops is grown in mixtures as well as species that provide fodder, fibre, spices, medicines, dyes and poisons - often up to 100 sown species in all (Box 3.2 *Mixed cropping in jhum fields*). Sowing and harvesting are more or less continuous throughout the two-year duration of the field. This ensures self-sufficiency in food in terms of calories,

Box 3.2.

Mixed cropping in *jhum* fields

'At the sides and against the swidden fences there is found an association dominated by low, climbing or sprawling legumes (asparagus beans, siva beans, hyacinth beans, string beans and cowpeas). As one goes into the centre of the swidden, one passes through an association dominated by ripening grain but also including numerous root crops, shrub legumes and tree crops. Pole-climbing yam vines, heart-shaped taro leaves, ground-hugging sweet potato vines, and shrub-like manioc stems are the only visible signs of the large store of starch staples which is building up underground, while the grain crops fruit a metre or so above the swidden floor before giving way to the more widely-spaced but less-rapidly maturing tree crops. Over the first two years a new swidden produces a steady stream of harvestable food in the form of seed grains, pulses, sturdy tubers, and underground stems, and bananas, from a metre below to more than 2 metres above the ground. And many other vegetable, spice and non-food crops are grown simultaneously.' [4]

and a great variety of foodstuffs. The *jhum* cultivators' diet is augmented by foods gathered and hunted from the surrounding forest. In passing, it might be noted that this diet is far superior to the diet of stale, contaminated (by pesticides and 'permitted' food additives) processed foods on which present-day urban dwellers must subsist. Most *jhum* cultivators also traditionally produced small amounts of saleable commodities.

Overall, therefore, the biodiversity of the forest ecosystem in which *jhum* cultivation is practised remains high provided the recovery period in the cycle is sufficiently long. It remains far higher than in sedentary farming areas where large proportions of the total original forest ecosystem are permanently deforested. In traditional sedentary farming systems this loss of biodiversity is compensated to some extent by mixed cropping. Even this is not done in modern monoculture farming, and as a consequence natural fertility restoration processes do not operate at all and crop growth is entirely dependent upon current chemical inputs. Dependence on chemicals, however, is, as we have seen, unsustainable, whereas systems that rely on natural processes of fertility maintenance possess the potential for sustainability.

Soil loss

Jhum cultivation with a sufficient recovery period exposes the soil surface of only a fraction of the farming system land area at any one time. For example, with a 30-year rotation, including a two-year cultivation period, only about 7 percent of the land is exposed at any one time. How damaging is this degree of exposure? I have suggested using soil loss as an index of damage (Chapter 2). The reference standard will be the measured rate of soil loss in natural undisturbed forest of the area being considered. In Table 3.2 a number of such values have been presented for the major soil regions of India and for tropical areas around the world. From these data it would appear that in general a rate of soil loss greater than about 0.5 t ha^{-1} yr^{-1} is damaging to any farming ecosystem, while the limit in many places may be only 0.05 t.[5] On a mountain slope where soil depth is, say, one metre and the rate of natural soil loss 0.1 t ha^{-1} yr^{-1}, an increase to 0.5 t as a result of farming would reduce soil depth by about 0.3 mm yr^{-1} . Farming could be continued for

perhaps several centuries but would eventually collapse. The reduction in crop yields that would occur would be more rapid than this simple calculation suggests because soils on hill slopes lose a proportionately greater amount of fine particles (silt and clay) (GBPUAT, 1982).

Table 3.2. Soil loss under natural, undisturbed forest

Location/ Situation	Rainwater runoff, % of total annual rainfall	Soil loss by water erosion, t ha^{-1} yr^{-1}	Reference
Natural forest in Western and Eastern Himalayas, black soil region, and Eastern and Southern red soil region	-	Nil	Dhruva Narayan (1993)
Submontane evergreen forest, Nilgiris	1	0.030	Chinnamani et al. (1965)
Central Himalayan oak forest 36-40^0 slope, 2050 m, rain fall 2820 mm	0.44	0.025	Pande *et al.* (1983/ 84)
Central Nepal, 35^0 slope, 1800 m altitude.	< 1	0.400	Impat (1981)
18 locations in the tropics	-	Median value 0.3; range 0.03-6.2	Wiersum (1984)

Hong (1994) quotes the findings of several investigators of *jhum* cultivation in Southeast Asia and Africa as follows:

1. 'In Sarawak... erosion and runoff occurring during the cropping cycle are very low and do not differ significantly from those under either primary or well-grown secondary jungle... Provided the organic matter content of the soil is high (that is, after a long fallow) soil erosion and runoff will usually not be serious under a shifting cultivation system... Even when

the fallow period declines in response to population pressure, the early stages of this trend may not significantly increase the rate of soil erosion.'

2. 'Soil erosion trials recently conducted by the Sarawak Agriculture Department of swidden farms on steep land of more than 25 degrees gradient have confirmed that soil erosion and runoff are insignificant. However when pepper was grown on these steep inadequately terraced slopes, very serious soil erosion and gullying occurred.'

3. In Africa: 'Traditional systems of cultivation in the forest admirably protect the soil from erosion in spite of steep slopes and heavy rainfall.'

Unfortunately, I have not been able to see the original reports thus quoted and examine the data on which these conclusions are based (see Note 3). Critical evaluation of soil erosion data requires information on soil type (erosivity), slope angle, and rainfall (total and intensity), all of which have a profound effect on the rate of soil loss when the soil surface is bared. The great variability of sites has been shown by Wiersum (1984) who has summarised the data of 22 measurements of soil loss from *jhum* fields at 7 locations. The minimum value is 0.4 t ha^{-1} yr^{-1}, the maximum is 70 t and the median value is 2.8 t.

In India, Chandra (2000) summarising Sachchidananda's conclusions on *jhum* cultivation (Sachchidananda, 1989), writes: 'When the system is efficiently operated, soil erosion is not greater than soil erosion under other agricultural systems that are efficiently operated.'

Several published figures for measured soil loss from *jhum* fields and fallows for North-eastern India are given in Table 3.3. These rates for the cultivation period are certainly high and are at variance with the observations quoted earlier by Hong (1994). It is not possible to reconcile these without full background information. The data in Table 3.3 indicate a somewhat lower rate of loss during the cultivation period for longer *jhum* cycles.

An obvious consideration is that the annual rate of soil loss averaged over the entire *jhum* cycle is much lower than the figure for the cropping period only. For example, if we assume a rate of 22.5 t ha^{-1} yr^{-1} on average for the two-year cultivation period in a 30-year cycle and 1 t ha^{-1} yr^{-1} average for the

fallow period, the average rate for the entire cycle would be 2.4 t ha^{-1} yr^{-1}. The corresponding rates for 10- and 5-year cycles would be 5.4 and 13 t ha^{-1} yr^{-1}. For purposes of comparison, traditional terraces in Uttarakhand were found to lose 3.9 t ha^{-1} yr^{-1} and even with terraces of improved design loss was 2.8 t ha^{-1} yr^{-1} (CSWCRTI, 1981 and 1984). Measured soil losses

Table 3.3. Measured rates of rainwater runoff and soil loss from *jhum* fields and fallows in Meghalaya, North-eastern India

Source	Description of site	Percent rain water runoff	Soil loss, t ha^{-1} yr^{-1}
Tokay and Ramakrishnan (1981) [1]	Freshly-burnt fields under cropping		
	30-year cycle	21	22.5
	10-year cycle	24	23
	5-year cycle	26	30
	Fallows		
	5th year	19	1.1
	10th year	13	0.8
Mishra and Ramakrishnan (1983) [2]	Freshly-burnt fields under cropping		
	10-year cycle	30	50
	5-year cycle	33	55
	Fallows		
	1st year	25	7.1
	2nd year	21	3.5
	10th year	13	2.0

1. One 10 x 1 m plot for each treatment; steep slope (angle not mentioned) on laterite soil; elevation <1000 m ?; study year (1978), very dry, 1420 mm vs. 2200 mm normal rainfall.

2. Four (?) 20 x 2 m plots for each treatment on 40^0 slope; elevation 1500 m; laterite soil; values averages for two years, 1977-1979; rainfall about 1785 mm yr^{-1}.

(These notes are those of Bruijnzeel and Bremmer (1989) from whom I have taken this table.)

reported for cultivated land in other parts of India by Dhruva Narayan (1993) are: Northern alluvial plains, 15 t ha^{-1} yr^{-1}; Assam valley, 27.9 t; black soil region, 64.9 t; red soil region, 2.7 t. (These figures are averages of several sites in each region.)

Overall, we can conclude that with sufficiently-long fallow periods (that is, periods determined in a rule-of-thumb manner such as described in the section on biodiversity) soil loss with *jhum* cultivation is not higher than for sedentary systems elsewhere in the country; at some places it is much less. This conclusion agrees with that of Sachchidananda (1989) referred to earlier. In absolute terms, soil loss under *jhum* cultivation in some areas renders the system unsustainable in the long run. At a few places the rate of soil loss appears to be low enough not to be a threat to long-term sustainability.

Recycling of biomass (that is, maintenance of circularity)

In *jhum* cultivation an obvious break in the complete recycling of biomass is the burning of the *jhum* plots after cutting and before sowing. To put this practice in perspective, it must be recalled that the original clearing of all forest land for agriculture everywhere in the world and at all times has involved cutting and burning. A niche, large or small, temporary or permanent, must be created in the forest for the growing of (foreign species of) food and other crops, and the only practical way to do this is cutting and burning. Overall, the reduction in ecosystem carbon content is less for *jhum* cultivation than in ecosystems permanently and completely cleared for sedentary agriculture; its contribution on a unit-area basis to global warming, therefore, is less than that of sedentary farming.

Coming down to earth once more: experience has shown that burning is essential for obtaining good yields with *jhum* cultivation. In areas where rain is more or less continuous and the cut vegetation does not dry out, burning is not done, and paddy yields are, according to Clarke and Hindley (1999), only one-third to one-half as much as in areas where burning is done. These writers do not give the source of these data and the validity of the comparison could be questioned as the yields at two different sites are compared. However,

lower yields where the slash is not burned is probable since the soils of this region do not contain an appreciable reserve of available minerals and the decomposition of the slash is probably not rapid enough to meet the mineral requirements of the growing crops. A similar depression of crop yields also occurs in the Central Himalayas in permanent-field agriculture where unripe compost (that is, farmyard manure) is incorporated into the soil at the beginning of the kharif (monsoon) season (VRIHA, 1980). Aside from the slow release of minerals, available nitrogen in the soil is temporarily immobilised by soil organisms feeding on the compost. The benefit of the compost is realised only in the subsequent rabi (winter) season. Burning releases minerals for immediate plant use, and does not result in the immobilisation of existing soil nitrogen. In unburned *jhum* plots forest regrowth is probably faster than in fields where burning is done, also adversely affecting the early growth of sown crop plants.

It is therefore necessary to sacrifice some organic matter and nitrogen in the interest of obtaining good yields from sown crops. Losses of minerals released by burning do occur via rainwater runoff and leaching, amounting to between 5 and 10 percent of the amount released, according to the studies in North-eastern India reviewed by Ramakrishnan (1985). All these losses appear to be made good during the subsequent fallow period provided it is sufficiently long (for example, 10 years was sufficient in a study of *jhum* cultivation in Thailand [Hong, 1994]). Recovery of the carbon, nitrogen and mineral contents of the system (soil plus vegetation) seems roughly to parallel the recovery of the vegetative cover as already described.

Ramakrishnan (1985) reports that in North-eastern India more than half the ash on freshly-burned *jhum* plots is blown away by strong winds during the dry period of March and April before the monsoon rains begin. This is surprising, and suggests that the area has generally been opened up and desiccated through a process of desertification caused by very short *jhum* cycles of 5 years or less. Indeed, his report includes a photograph of such a desertified area. The occurrence of short *jhum* cycles and the downward spiral to the collapse of the system will be discussed later; blow-off of ash appears to be just one of the effects as well as causes of this downward spiral.

Adaptation of species or varieties to the local ecosystem

In planting cultivated crops the *jhum* farmer creates a remarkably stable sub-ecosystem based upon his or her knowledge of the growth requirements of every component so that full use is made of sunlight and soil nutrients, and of the complimentary relationships among crops. To quote Rappaport (1976): 'The Maring gardener is expert at taking advantage of micro-environmental variations and there is a reason for each plant to be where it is.'

In a given area, perhaps in some cases even a single plot, several varieties of the same crop are grown, having been selected over time for their adaptation to varying soil conditions and farmers' needs. Thus Sharma and Sharma (2000) report that 13 varieties of paddy are grown by the Lakhers of Mizoram.

I have not come across any references in the literature on *jhum* cultivation to problems of crop pests or diseases. Crops are undoubtedly eaten by insects and afflicted with fungal diseases, but the extent of these must be small so that it does not occur to farmers to attempt any control measures. This suggests that adequate crop protection is assured through careful selection of species/ varieties for adaptation to the local ecosystem. Crops are, however, protected from forest animals like bears and pigs (Sharma and Sharma, 2000).

The main species of domestic animals maintained by *jhum* -cultivating communities in North-eastern India are the *mithun* (*Bos frontalis* Lambert), probably a domesticated version of the wild *gaur* of the region (Mondal and Pal, 1999), and the pig, presumably also domesticated locally. These are maintained on forest grazing/ foraging, with the pigs being given supplementary food from crops. Sharma and Sharma (2000) report that the cow was introduced in the 19th century and that with improved communications in recent times, the numbers of both *mithuns* and cows have increased. Such an increase might well be affecting forest regeneration adversely, but there do not seem to be any observations on this subject. The wild *gaur* was a part of the original climax forest ecosystem of the area, and at low population densities domestic *mithun* presumably fitted this same niche without altering the floristic composition of the climax forest.

Cash cropping

Today there is more pressure than ever on all traditional farming communities the world over to undertake cash cropping on an increasing scale. *Jhum* cultivators appear to be no more resistant to such pressure than other traditional communities. The adverse effects of extensive cash cropping on sustainability were described earlier in a general way. Vitebsky (1998) has described in detail how the money economy has destabilised the *jhum* -cultivating communities in Odisha: how their increasing need for cash forces them to sell more minor forest produce and even food they themselves need, and how their traditional beliefs regarding sustainable land use are over-ridden by the compulsions of the marketplace, leading them to expand cultivated area and thus reduce the length of *jhum* cycles to 5 years or less. As in North-eastern India (Ramakrishnan, 1985) when the length of *jhum* cycles has been reduced to this extent the forest completely loses its ability to regenerate, thus creating, in effect, a desert. In the terminology of Fernandes et al. (1988) (who have studied tribal societies in Odisha), whereas earlier the *jhum* cultivators' relationship to the forest was of 'constructive dependence' in which they managed their forest ecosystem more-or-less sustainably, their new relationship is of 'destructive dependence' - one in which they must destroy the forest to survive in the short run.[6]

Population control

Population increase has usually been cited as the cause of the shortening of *jhum* cycles. This is an oversimplification at best. Some *jhum* cultivating communities did effectively control their population size, as we have seen (Chapter 2), but possibly not all, and population growth in some *jhum* -cultivating communities may have occurred. However, Fernandes et al. (1988) report that in Odisha population increase in tribal areas between 1971 and 1981 was lower than for the state as a whole, which was in turn lower than in most of the rest of the country, and conclude that population increase of *jhum* -cultivating communities *per se* was only a minor part of the problem. Perhaps more important, governments have alienated some of the *jhum* cultivators'

original territory to construct dams, for mining and for commercial, clear-felling timber extraction. This has left the people with less land, necessitating a shortening of the *jhum* cycle. Fernandes et al. (1988) also describe how land alienation in areas of settled agriculture in Odisha displaced people to more remote forest areas where they have taken to *jhum* cultivation.

Stable farming community

When the present-day money economy, government administration and 'development' penetrate areas of previously isolated communities, very few, if any, such communities can withstand the pressure. *Jhum* cultivators are apparently no exception according to the reports of Fernandes et al. (1988) and Vitebsky (1998). Changes occur at two levels, so to speak. There are the obvious changes in the material conditions of life - the farming system and lifestyles. There are also psychological and spiritual changes, as traditional religious worldviews break down and are replaced by the 'religion' of consumerism. The changed material situation presupposes a changed worldview; adoption of a different lifestyle willy-nilly changes people's view of themselves, and of their relationships to other people and to the environment. The alien worldview legitimises the over-riding of self restraints mandated by the traditional worldview. The sustainable use of natural resources is replaced by profit maximisation in the short run, or as we have said in the section on population by 'destructive dependence' on the environment. Population control measures, to the extent they were a part of the traditional culture, are probably also over-ridden.

Discussion

In terms of the maintenance of biodiversity *jhum* cultivation clearly scores higher marks than any system of sedentary agriculture. In terms of soil loss also, it is generally superior to sedentary agriculture. It is at least equal to traditional sedentary Indian farming in terms of circularity and reliance on adapted species or varieties. Overall, therefore, *jhum* cultivation is somewhat superior to traditional sedentary Indian agriculture and vastly superior to modern chemical agriculture. It hardly deserves the label often given it, 'environmentally destructive'.

Nevertheless, traditional *jhum* cultivation is not sustainable in many places because of relatively high levels of soil loss. In view of this, and because existing sedentary forms of agriculture are no better, indeed, they are usually worse, I suggest that it is only prudent to give the highest research priority in the future to devising systems that do not cause soil loss, which really means systems of crop production that do not require ploughing, mechanical weeding or burning. One model from the past that might be studied with advantage is the Javanese multi-storey garden system (described in a subsequent section) that evolved out of *jhum* cultivation in response to the need to intensify agriculture in a tropical mountainous area.

In respect of the capacity to regulate population size in relation to area, and to withstand outside influences that reduce sustainability, *jhum* -cultivating communities appear to be no better than other traditional farming communities. For these reasons alone we must conclude that *jhum* cultivation is unsustainable. I will return to a consideration of this aspect of the question later. Here it needs only to be pointed out that if *jhum* cultivation has no future in the current global economy then neither does any other form of agriculture now practised.

The facts about *jhum* cultivation presented in this chapter do not support the hypothesis of Chandra (2000) that *jhum* cultivation is a 'primitive precursor' of subsequent, more 'advanced' forms of agriculture. Indeed, a contrary hypothesis seems to be required; that is, that *jhum* cultivation is, though perhaps the earliest form of agriculture to be devised (Chandra, 2000), more environmentally sound and hence potentially sustainable than systems which followed it. In other words, so-called 'developments' in agricultural systems from *jhum* cultivation through various forms of traditional sedentary agriculture to present-day chemical agriculture, are in reality stages in a continuous degenerative process.

Let us consider this assertion in more detail. Historical evidence clearly suggests that *jhum* cultivation is indeed an ancient form of agriculture, practised in South America, Africa, Europe and Asia; Chandra (2000) claims that archaeological evidence suggests that it has been in existence for some 9000 years. It is an extensive form of agriculture, able to support only a low

human population per unit area.[7] It appears likely that as population density increased, a *jhum* -cultivating community had two options: limit population size or migrate. They chose one of these, it would seem, in preference to exceeding the carrying capacity of the local ecosystem and destroying it. A third option was also available in some regions - intensification by converting to permanent-field agriculture. Thus, in Europe *jhum* cultivation disappeared long ago[8], presumably because the soils, climate and topography made this possible. Where this option was not available for ecological reasons – for example, in the tropical mountainous areas of the world – *jhum* cultivators had recourse to one of the other two options already mentioned. While sedentary, permanent-field agriculture solved the immediate population problem in some areas, the farming system, as we have seen, became less sustainable. Diets became less diverse. This trend continued as traditional forms of sedentary agriculture gave way to modern mechanised, chemical agriculture. Figure

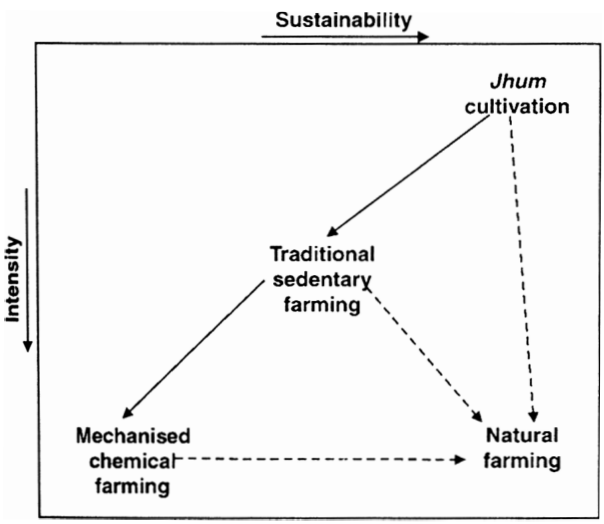


Figure 3.1. The history of agriculture (solid lines) has been of increasing intensity (food production per unit land area) and decreasing sustainability. In the future (broken lines) all farming systems should be self-sufficient in energy, self-manuring, dispense with ploughing, mechanical weeding and burning, rely on locally-adapted species or varieties, and maintain high biodiversity.

3.1 summarises this hypothesis and suggests that all presently-existing farming systems must rapidly evolve to more sustainable natural systems.

Trees and sustainable agriculture

This study of *jhum* cultivation highlights a theme of crucial importance to all agricultural systems, namely the role of trees in ensuring sustainability. In Chapter 1, I have described the concept of 'support area'. In essence this means that crop production, to be sustainable, must be supported by the growth of trees within the farming system itself. The trees may be in separate plots, as for example in Indian village forest, interspersed in cultivated land as in alley cropping, intimately mixed with crops as in Javanese multi-storey gardens (see below), or alternated with cultivation, as in *jhum* cultivation, but in all cases, as much attention must be given to them as is given to cultivated crops. (The monoculture of commercial trees for timber or pulp in 'farm forestry' does not serve the function of ecosystem maintenance, being more of the nature of cash cropping.) *Jhum* cultivators are very solicitous of their forest trees. Traditional sedentary farmers are less so, and the modern farmer thinks a bag of chemicals can replace trees altogether.

Conceptually, one may visualise the process of establishing a sustainable farming system as integrating sown species (crops) into existing forest, as in *jhum* cultivation and traditional Indian sedentary agriculture, or of introducing trees into hitherto exclusive cropland as in alley cropping. In whatever way one approaches the matter, there will be found, I think, a minimum value for the proportion of the total farming ecosystem area that must be maintained in trees to ensure sustainability. This proportion can be determined by experience, as the traditional *jhum* -cultivation system illustrates, or by taking into account the areas of trees needed to meet ecosystem requirements of fuelwood, and the protection of environmentally fragile areas (for example, very steep slopes).

This concept, if explicitly formulated, would bring more realism into national policy planning for both agriculture and forestry. Trees in the farming system can have a commercial role as well as their regenerative, supportive role; for example, stemwood production, if a part of a balanced farming system, can be a valuable cash crop, reducing the need for government forests which are

at present almost impossible to manage sustainably. (A 'balanced' farming system is one in which the minimum area of trees needed for various ecosystem functions is met and requirements of non-wood biomass [for example, food, fodder] are also met.)

Javanese multi-storeyed gardens

In Java (Indonesia) permanent field paddy growing has traditionally been followed in lowland areas and *jhum* cultivation on mountain slopes. In response to increasing population, *jhum* cultivation was intensified at many places by converting *jhum* fields to permanent gardens that imitate the natural forest of the area (Freeman and Fricke, 1984). This is accomplished in a *jhum* field by continued selective weeding and planting to give in time, a three-tiered, closed-canopy vegetative cover: an upper tier of tall timber and fruit trees, a middle tier of lower-growing bushes and small trees producing fruit, vegetables and spices, and a ground cover of cereals, pulses, vegetables, tubers and spices. The soil surface is continually covered so that there is virtually no soil erosion. Most gardens include a pond in which fish are grown. Many of these gardens are known to have been in continuous existence for several centuries. Their maintenance depends upon a thorough knowledge of the natural forest of the area and skill in manipulating introduced and natural plant communities to imitate the structure and functioning of natural forest. Food production in these gardens equals that of permanent lowland paddy cultivation per unit area. Further, the food produced is far more varied. The system is, like all traditional systems, a product of the culture of the people and their environment. It is, perhaps, unique and attempts to replicate it elsewhere do not appear to have been made. It is valuable because it demonstrates the possibility of permanent, apparently sustainable agriculture in the difficult conditions of tropical mountainous areas. It possesses all the advantages of *jhum* cultivation, and is superior to it in that there is little or no soil loss

National economic policies and sustainable agriculture

The larger aim of this chapter has been to illustrate the method of ecological evaluation of farming systems, by means of a critique of *jhum* cultivation.

The ecological principles used can guide us, both farmers and scientists, in modifying existing farming systems, or in devising new ones, in the future. However, whether or not we achieve sustainable agriculture in the future will, as this chapter has also shown, depend ultimately not on technical considerations, but economic ones.[9] The current national/ global economic framework simply cannot accommodate sustainable agriculture.

Let us enquire then what national economic policy framework would be needed to foster sustainable agriculture in India in the future. If there is any one clear lesson to be learned from the study of agricultural history in Asia, it is that our primary concern in framing economic policy must be to ensure national food security. Today we are rapidly losing control over our agriculture to multinational seed, chemical and food processing/ marketing corporations and oil-exporting countries. That is, we are losing control over what we grow, how we grow it and to whom we sell what we grow.

By the term 'food security' I mean the provision of adequate amounts of food as well as sufficient variety to ensure good health to all, both now and in the indefinite future. At present, we are satisfied that we have a sufficiency of cereal grains. We do not reckon that to achieve this a majority of our people have diets lacking in adequate pulses. (We also have a large shortfall of edible oils, which we partly make good by imports.) We are pleased to be exporting vegetables, fruit and fish that a majority of people in the country need on bare nutritional grounds. We gladly export oilcakes that our farmers could use to produce the milk their children so badly need and which contain the plant nutrients our soils so badly need. We hail it as 'progress' when multinational corporations set up contract-farming operations for vegetables for export in an already agriculturally-ravaged Punjab. These activities sacrifice national food security to the logic of the global marketplace.

The main ingredients of a policy that would ensure national food security, as defined here, would, I suggest, be the following.

1. Better water management at the village level

   This would include: 1) reducing groundwater use to sustainable levels, that is, balancing pumping and recharge rates; 2) reduce seepage losses

from irrigation canals and channels; 3) hold rainwater in/ on the land where it falls, that is, water harvesting and storage, including storage as groundwater.

2. Energy self-sufficiency at the village level

   Traditional farming systems are largely independent of external energy inputs. Attention needs to be redirected towards traditional local energy sources – bullock power and fuelwood – as well as towards methane gas, direct solar energy and micro-hydel power. No-tillage farming methods, if they can be devised, would reduce energy requirements substantially.

3. Reliance on regenerative/ sustaining natural processes within the farming system.

   Government subsidies on agricultural chemicals, diesel fuel and rural electricity need to be discontinued and the money saved put into relevant rural school education and health care, the encouragement of urban composting schemes, small-scale local food processing units, local water-harvesting projects, village small-scale industry, and village forest rehabilitation projects.

4. Limiting the area of operations of multinational corporations in the fields of agricultural production inputs, crop contracting and food processing and marketing.

5. Reversing the present flow of economic and ecological refugees from rural areas to urban centres.

6. Limiting the export of agricultural produce.

7. A forest policy that puts forest land back into the hands of rural communities.

8. Implement land reforms fully.

   Our post-independence programme of land reforms has not, in most states, been completed. This needs to be done.

9. Re-orient agricultural research and education to natural farming.

   The ways in which such an agricultural policy could be pursued are described in Chapters 5 and 9. The adoption of such a policy could not

be done in isolation. Two obvious implications are the need to reduce foreign-exchange expenditure to compensate reduced earnings from the sale of agricultural commodities, and a need to rethink industrial policy in general. Changes of this sort would require considerable belt-tightening on the part of the better-off section of society. Government would need to resolve firmly to 'swim against the current' of globalisation.

Notes

1. *Jhum* , or shifting cultivation is widely practised in most upland tropical regions of the world. A long-term rotation of natural forest (10 to 50 years) and cultivated crops (usually two years) is followed. The forest vegetation is cut, dried and burnt before the onset of the rainy season and seeds are dibbled. A variety of crops is grown for two years and then the field is allowed to revert to forest.

2. These criteria are: maximum biodiversity, continuous soil cover, circularity in the flows of energy and minerals within the ecosystem, adaptation of species to the local ecosystem, limited cash cropping, human population control, and stability of farming communities.

3. In her book Natives of Sarawak (Masyarakat Berhad, Penang Malayasia, 1987), Evelyn Hong has reviewed many studies of *jhum* cultivation in Southeast Asia. I have not been able to obtain this book, but the chapter on *jhum* cultivation has been reprinted, minus the full references to sources cited, in the book Back to the Good Earth: Damaging Effects of Modern Agriculture and the Case for Ecological Farming (Third World Network, 1994). I am therefore unable to give full references to her sources. The quote about *jhum* cultivation in Africa she says is from Nye and Greenland (1960) which is widely quoted but which I have also not been able to see.

4. This quote is taken from Clarke and Hindley (1999) who in turn say they are quoting Harold Conklin, but they do not give the source. Conklin is a well-known investigator of *jhum* cultivation. Chandra (2000) refers to some of his work, with full references.

5. That there is very little soil erosion in natural undisturbed forest can be verified by walking through such a forest during a heavy rainstorm. Rainwater soaks into the soil and very little will be seen to run off; what does occasionally, run off is clear. When the soil is saturated, clear water seeps out into ravines and is safely carried away. How then do we explain the fact that rivers emerging from forested mountain areas like the Himalayas carried large sediment loads even before there were an human

beings present? Most of this sediment came from landslides and the down- and side-cutting of streams and rivers (Bruijnzeel and Bremer, 1989; Ives and Messerli, 1989); a good part of present-day river sediment load continues to come from these naturally-occurring processes.

6. *Jhum* cultivators have, for at least the past two centuries, been accused of 'destroying' forests by those (that is, forest departments and industry) who wished to extract timber and pulpwood from the forests occupied by the *jhum* cultivators. This was the excuse used for banning *jhum* cultivation by the British in South India in the 19th century (Chandran, 1998) and by other colonial governments throughout Southeast Asia. This accusation appears to have even greater force today when *jhum* cultivators are clearly the agents of forest destruction. Our analysis here clearly shows, however, that traditional *jhum* cultivation, though modifying forests somewhat, did not destroy them. Present-day *jhum* cultivators are not the culprits behind forest destruction, but the victims of powerful political and economic forces that they cannot avoid or control. As victims they suffer not only economic distress but also intense culture shock when they are displaced (Hong, 1994).

7. One estimate of human population density in traditional *jhum* cultivated areas of tropical mountainous regions is 3 ha. (on an average) of total forest per person (Clarke and Hindley, 1999). The average value for traditional sedentary agriculture in India (cropland plus village forest) is in the region of 0.5 ha. and in areas of green-revolution agriculture it is perhaps only 0.1 - 0.2 ha.

8. Chandra (2000), citing as his source the International Encyclopedia of the Social Sciences, volume 1, 1968, writes: 'In European countries, the practice of shifting cultivation has receded and more advanced techniques of cultivation have been adopted and there has been a tendency to see it as a primitive level that ought to be replaced or even forbidden.'

9. The September 2000 issue of The Ecologist (volume 30, number 6) carries a special supplement entitled 'Globalising Poverty: The World Bank, IMF and WTO - Their Policies Exposed.' The destabilising effects on agriculture in Asia, Africa and South America of the policies and programmes of these institutions are detailed.

4

Rural Communities Going their Own Way

Hundreds of on-farm trials of the new varieties of crops and the new management techniques developed in our universities and research institutes have been carried out by scientists and extension workers in the North Western Himalayas for many years. These trials have demonstrated, to the satisfaction of the scientists and extension workers, that these are superior to existing varieties and techniques. However, rural people have not, with only a few exceptions, adopted them (VRIHA, 2002). Why this is happening?

Farmers eagerly try out new seeds. They exchange seeds with each other, and also sometimes try out and adopt new varieties from the experiment stations. In Sialdeh Block, Almora District, Uttarakhand, farmers took up the cultivation of Taichung Native -1, a dwarf variety of paddy, in the 1960s and continue to grow it long after it has been officially superseded. In the upper catchment of the Dhauliganga and on the lower catchment of the Mandakini, in Chamoli and Rudraprayag Districts, respectively, of Uttarakhand, extensive areas of wheat varieties imported from Mexico at the beginning of the Green Revolution 40 years ago are still found long after these varieties were officially superseded (Pant, 2002).

I have observed an interesting example of farmers' openness to change in Artola village in Dhauladevi Block, District Almora in Uttarakhand. This is an unirrigated upland village at an altitude of 2000 metres. The residents of the village are proud of their local wheat variety with its large yield of straw and good grain quality. No one in the village remembers where it came from, or exactly when it came to the village, but its adoption was presumably based upon careful observation and comparison over a number of years with the varieties they grew earlier. Selective harvesting for seed subsequent to introduction probably further improved its adaptation to conditions in this village. And yet, the people of this village also grow, in one part of the village in a few fields with heavier-textured soil, a Vivekananda Institute variety.

It cannot, therefore, conclude that the people of the NWH region are resistant to change. If they reject new technologies, or occasionally adopt them in spite of official policy, then I think it must be assumed that they have definite reasons for doing so, and that these reasons are simply not apparent to scientists. Have the scientists really tried to understand their reasons?

Similarly, people in the NWH have had access through government shops to chemical fertilisers and pesticides for the past several decades, but, except for a few instances (irrigated bottom land, commercial fruit belts and, sometimes, on cash crops like potatoes and vegetables in unirrigated fields), they do not use them. They will not use them on crops they themselves consume, which is about 90 percent of all crops.

To summarise: modern agriculture has been rejected by a majority of people in the country, that is, in all dryland areas, and not only in the NWH. Where it has been adopted it is, after some three to four decades, bringing ruin to farmers, the land and our national food and water supplies. Reports are now coming in from people in the NWH as well of soil deterioration from the use of chemicals. In view of this evidence, scientists cannot simply conclude that the people who reject modern agriculture do so out of ignorance or stubborn refusal to modernise. Instead, it should, I suggest, prompt them to question their basic assumptions about modern agriculture. If they can do this successfully, they may be able to visualise and entirely different sort of agriculture.

This is a very big undertaking, and in this chapter it will not be possible to do more than outline what needs to be done. The next section indicates what specifically needs to be questioned and gives a few brief illustrations of what the results might be. Following that a brief enquiry is made into the mindset of traditional rural people. Finally my own proposal for an authentic Indian way of thinking about agriculture will be sketched. Elaboration of this proposal will be given in the chapters that follow.

Questioning existing assumptions

An effective way to begin our questioning is to attempt to define the various concepts we employ when thinking about agriculture. These concepts include: mineral nutrients can take the place of compost in growing crops; 'production'; 'development'; 'management'; 'technology transfer'. Having defined them we must then critically examine them for their logic and their usefulness in practice. With the growing awareness of environmental deterioration, the concept of 'watersheds' has become common, particularly in the context of land use in mountain regions; this concept also needs our scrutiny. Come to think of it, concepts of 'farmers' and 'agriculture' also need to be questioned.

The concept that fertilisers can replace compost

The fact has been noted that people in the NWH do not, by and large, use chemical fertilisers. One reason is simply that they do not give consistent results in dryland areas with uncertain rainfall. A family's investment in fertilisers can be lost. There is, however, a deeper reason. People feel that substituting fertilisers for compost is un-natural, unhealthy and bad for the soil. They do not use them on food crops they consume themselves, though they are willing to use them on commercial crops. In the latter cases, the profit motive over-rides their innate conviction that fertilisers are harmful. Or, they are initially unaware of the long-term deleterious effects on their soils. In some villages of the mountain region of Uttarakhand people have taken up intensive vegetable cultivation with assistance from development NGOs. In meetings between village people and UEEC staff they report that after as few as five years they have noticed a deterioration of their soil in terms of its mellowness. Others

report having tried fertilisers briefly for vegetable production but have felt that the lush vegetables that result are poor in nutritional value. They return to the use of compost.

This verdict on the use of chemical fertilisers agrees with that based on the results of careful research. In 1885 the first permanent manurial trials in India were begun at Kanpur. Subsequently similar experiments were laid out at other locations in the country. Intuitively recognising the issue of what we today term 'sustainability', these experiments were long term – continuing for four or more decades without change in the treatments. Of particular interest today are the results of the experiments at Pusa, Bihar, the original site of the Indian Agricultural Research Institute. In two experiments exclusive chemical fertilisation and exclusive compost manuring were compared. Crops were otherwise grown using traditional, local farming practices, and traditional crops, though of improved varieties that were available at the time. The experiments ran continuously from 1930-1 and 1931-2 for the modified old and the new manurial experiments, respectively. They continued until 1969. These experiments are described by Nambiar (1994).

The results showed a clear-cut superiority of organic manuring over chemical fertilisation in terms of grain yields averaged over the 40-year period (Nambiar, 1994). Unfortunately, the complete data have never been published, nor has any attempt at analysing the data for time trends for yields or soil parameters been reported. Had this been done we might have gained considerable further insight into this issue. (My own hypothesis is that there were steady declines in yields in the fertiliser plots over the 40 years, while yields in the compost-manured plots remained steady or even increased.) Nevertheless, the average yield data are sufficiently indicative to vindicate the traditional view that the use of fertilisers is dangerous. It should have alerted agricultural scientists to the need for further careful long-term studies along the lines of the Pusa experiments. But no notice was taken. Thirty years later, a request for the publication of the full data (Jackson, 1999) has been completely ignored.

The background to this neglect of the results of the Pusa experiments is instructive. In Box 4.1, *The Pusa long-term manurial experiments*, I give my own reconstruction of what happened. If this reconstruction is correct, it is

Box 4.1.

The Pusa long-term manurial experiments

The Pusa long-term manurial experiments were terminated in 1969 – rather abruptly it appears to me, and without subsequent adequate analysis of the data. That was the time that the 'All-India Co-ordinated Research Project on Long-term Fertiliser Experiments' was launched. These experiments were formulated with clear-cut, pre-conceived ideas. In the first place there was no exclusive organic manuring control; second, there was no crop rotation (in a traditional sense); and third, they employed high-grain, low-straw yielding foreign varieties of crops. This latter feature meant that proportionately less organic matter was produced for potential recycling.

At that time, in the late 60s, a sudden paradigm shift in scientists' thinking occurred – a change in their conception of crop production from an organic to a purely chemical-physical process. As a result, the framers of the new long-term experiments probably felt that they were making a decisive break with the past, and hence had nothing to learn from the earlier Pusa long-term experiments. The chemical-physical concept of crop production steadily gained ground worldwide from the time of Liebig, Lawes and Gilbert. In India, after being introduced by the British colonial administration at the end of the 19th century, it was treated with considerable circumspection until, in the 1960s, it became mainstream scientific dogma. Until the 1960s agricultural teaching and research had, by and large, reflected a traditional, organic conception of crop production. This view gave way completely in the 1960s to the chemical-physical view. This was a necessary component of the vast modernisation agenda based upon a Western cultural model that we adopted after independence.

There were pressing political reasons also. The 1st and 2nd Five-Year Plans (1951-6, and 1956-61) outlined a social, essentially Gandhian, solution to low food production. This was opposed by powerful rural vested interests which did not want change in the status quo. The stage was thus set in the 1960s for the entry of American 'aid' as an alternative, technical solution to the problem of low food production. It was eagerly accepted as a means out of a difficult political situation. On the American side, this 'aid', needless to say, was also motivated by political considerations growing out of security and commercial interests.

(Adapted from Jackson, 1999)

instructive in that it reveals what determines current scientific assumptions, and reveals above all that scientists' assumptions are just that - assumptions. This subject will be considered in more depth in the next chapter.

The concept of 'production'

At first sight, the meaning of the word 'production' seems to be simple enough and unambiguous. And yet, rural people in the NWH do not accept new varieties that give greater 'production' in on-farm demonstrations. Maybe there is a need to ask the question: production of what? Scientists assume that production refers to grain yield and that the people on whose fields we conduct demonstrations think likewise. Either they are irrational or they have a different definition of production. The residents of Artola village (mentioned earlier) give us a hint of a definition: production for them is measured in terms of animal fodder (both quantity and quality) and in terms of the eating quality of the grain (a qualitative definition) in that order. The primary importance, in their minds, of fodder is not simple-minded, but shows profound understanding of the farming system and how to ensure sustainability – of the need to produce biomass, other than for human food, for recycling to the soil. This is a lesson that we scientists need to learn. The same insight is motivating village women's groups to rehabilitate their village common land to produce more biomass (fodder, fuelwood and dry leaves for animal bedding). The need to 'balance' ecosystem biomass production was mentioned in Chapter 1. At first sight it might seem that this would reduce the production of biomass for direct human use, but is necessary if the ecosystem is to remain healthy – and by extension, if the crops grown in it are to remain healthy and productive in the long run.

From the point of view of ensuring crop health, and hence long-term productivity, it will be seen that the notion that 'improved' varieties developed in the experiment station and transferred to the village will increase production is simplistic. If the new variety can survive at all in the new setting (that is, in a balanced, healthy ecosystem), it may still need a period of careful observation and selection in that setting. There is evidence, already cited, that village people in fact do this; after all it is crucial part of the establishment and continuance of crop cultivation. The history of cultivation is of one continuous

effort to find or develop new varieties that are better adapted to the local ecosystem, appropriate to the needs of the residents, and that give high and sustained yields. Until recently rural people themselves, in their own villages, have done this. Only in the past century and a half has this function been taken up by the modern agricultural scientist working in the university or research institute. Overall, this later development has not been very successful because the 'improved' varieties usually presuppose the application of chemicals and other interventions which, in the long run, weaken or destroy the ecosystem. Perhaps village communities should again assume the primary responsibility for the development of new and better crop varieties. This suggestion is introduced in this chapter and developed more fully in Chapter 9. (See also, Jackson, 2002 b)

The concept of 'development'

When this word is not qualified, it means 'economic development', that is, an increase in money incomes. Such development has not, however, except for some two decades of so at the beginning of the green revolution, increased money incomes of rural people appreciably, and its narrow focus has caused environmental degradation, ill health, and, especially after the start of economic 'liberalisation', economic distress. Almost all the improvement in the material standard of living in the rural areas of the NWH over the past five decades is due to remittances sent home by migrant workers from the area.

The fact is that there are several types of poverty affecting rural people, and not just monetary poverty. Equally important is the ecological poverty mentioned in Chapter 1. Another type of poverty is what might be termed social poverty – the breakdown of community and tradition with forced migration of men to the cities in search of jobs, leaving women and children behind in the villages. Moreover, as a result of school education and the media, both projecting the image of the 'good life' in the city, young people in rural India do not want to work on their land or live in their village and try to leave if they can. If they cannot get employment outside the village, they consider themselves, and are considered by the community, as 'failures'. This leads to frustration and anti-social behaviour.

A third type of poverty is a poverty of meaning. Meaning in life comes from participation in community and rootedness to place. These are absent in the city and are disappearing in the village as the corrosive power of modernisation invades it. All these forms of poverty must be addressed. Monetary development neglects other types of poverty – indeed it is to some extent their cause - while it does not really alleviate rural monetary poverty. Rural women in the NWH understand this (UEEC, 2005) – in contrast to planners, administrators, scientists and donor agencies.

Another reason to question the current concept and practice of development is that it casts rural people in the role of passive recipients of development 'packages' rather than as active agents initiating change for themselves. If they were to set their own development agendas and execute them, all three types of poverty would be addressed.

The concept of management

'Management', to the agricultural scientist, planner and administrator, means the manipulation of natural processes in terms of the latest scientific concepts, technologies and systems. All these activities are based upon the premise that we understand the 'laws of nature' and can accurately predict the outcome of any management decision. This assumption is contradicted by the fallout from the green revolution – the unexpected and 'unfortunate' side effects. Strenuous efforts are being made to explain these side effects away, or to 'fine tune' our management models, but it is increasingly difficult to avoid the conclusion that there is a need to pause, step back, and reconsider the most basic categories of thought in terms of which our contemporary science paradigm is framed.

There is also now convincing evidence from within the scientific establishment itself that our contemporary picture of the universe must be radically revised (see, for example, Capra, 1997). In the newly emerging science paradigm for dealing with living organisms and natural systems (like ecosystems) the concept of accommodation replaces that of manipulation. Management in the future must aim at gently influencing whole systems (for example, a village ecosystem) and not violently manipulating their component processes piecemeal (for example,

by spraying a pesticide). This type of gentle management resembles in many ways traditional Indian management practices, a topic that will be explored in Chapter 8.

The concept of technology transfer

When the technical 'packages' that are sought from the research centre to the village are themselves suspect, then transferring them is meaningless. Further, is it really possible to reproduce village conditions in the experiment station in order to create really useful new technologies. Clearly it is impossible to imitate even one village with all its geographical and human peculiarities, and there are thousands of villages in widely differing situations in the NWH. All this suggests that research to develop new varieties and practices should be done in each village itself and by the people of the village themselves.

The concept of watersheds

In response to the need for rehabilitating land in mountainous regions, the watershed has been adopted as a guiding and organising concept. This concept was devised in the USA as an aid to managing uninhabited (by human beings) wilderness areas. Watershed management is done by professional government employees. Applied to the inhabited watersheds in India, it has also been a government undertaking, although attempts are being made to enlist the participation of the local people. This has been found to be problematic. The success of a watershed project depends upon the degree of genuine participation of the people living in the watershed, and this is usually only nominal (Mohanty, 2002). The project is often conceived, planned and directed by government officials and local people have no sense of ownership of the project. A sense of ownership is difficult to achieve unless residents themselves conceive, plan and direct the project (maybe with government or NGO participation). Since a watershed usually contains several villages, and often parts of several others, a community having a common interest is difficult to establish. It is easier with a single village, and this is why the actual implementation of watershed projects is often done on a single-village basis (Joshi *et al.*,

1995; Baviskar, 2003). This is an acknowledgement of the superiority of the single-village over the watershed as a unit for land rehabilitation and management. And, of course, if all the villages in a given watershed successfully rehabilitate and manage their land and water resources, watershed objectives will largely be met. The watershed concept as an organising theme has thus proved largely irrelevant in India, and to that extent it prevents us from trying other, more relevant concepts.

'Farmers' and 'agriculture' too are mere concepts

The concepts of 'farmers' and 'agriculture'; these concepts are abstractions from a larger reality, and like all such abstractions are dangerous. The whole from which they are abstracted is a community of people living in a given geographical area from which they derive their identity and their sustenance. When scientists use the words 'farmers' and 'agriculture', it signals that they are thinking of rural people only in respect of their activities of ploughing fields, manuring them, sowing, tending and harvesting crops, and also caring for animals. All other aspects of their lives are excluded from our conceptual focus. This is a sure recipe for disaster. One simply cannot understand their reasons for doing what they do in their fields in isolation from their total life experience as individuals and as a community. Moreover, suggesting that they manipulate phenomena in this limited domain of 'agriculture' is fraught with the possibility of disrupting their larger lives and the life of their community. Fortunately, rural people in the NWH have so far largely foiled their efforts to label them 'farmers' and their activities as 'agriculture'.

A new mood

We have seen that modern development casts people in the role of passive recipients of 'packages' (technologies, projects, services and welfare). This is in the best colonial tradition. The British governed India by keeping a tight, centralised control of natural resources and people, in the interests of their own economic advancement (Randhawa, 1983, p. iii). They also created an elite class, through a Western-style educational system and a set of privileges, to help them govern. The educational system emphasised Western science.

Whatever our station in life, we Indians were told what to think and what to do. Things have not changed much since then.

Rural people in our country created a sophisticated and long-enduring system of land use. They were obviously inventive and experimentive in outlook. Research was built into their everyday routine. This changed with colonisation. It is my experience that these traditional features of rural life still exist, but since the knowledge of rural people has been delegitimised by modernism, they do not display it to administrators, scientists and other *sahibs*. They do not accept our new varieties but they do not openly say that, from their point of view, they are useless. But things are beginning to change. In Uttarakhand, women are leading the way, learning to argue with those who think they know better, to innovate on their own again and, overall, to regain lost self-confidence (UEEC, 2005). In green revolution areas of the country increasing numbers of families are experimenting on their own with alternative systems of land management and the growing of crops (Alvares, 1999). There are many and serious problems in traditional rural life, but they cannot be solved by development, 19th-century-style Western science, global communications and markets. There is, however, this new and growing determination of rural people to solve these problems themselves, in their own way, by their own efforts. This needs to be officially encouraged and facilitated. Here again is a challenge to us scientists, administrators, aid-agency personnel and policy makers to question the way they think.

An alternative vision

The alternative vision that I wish to suggest as a basis for sustainable living in the NWH is a holistic one, based upon the following concepts.

1. The village ecosystem as a geographical, social and economic unit (see Chapter 1).

2. Development as a process of community learning that transforms it from a passive recipient of 'packages' to a fully-empowered agent, planning its own future and working to implement it.

3. Learning that begins with an attempt to understand the natural, human and social processes operating in a village ecosystem, a willingness to foster these and to live within the limits they impose.

4. Agricultural scientists, government servants and NGO personnel as participants in programmes of development and learning as spelled out in 2 and 3 above.

Achieving this vision is an unprecedented challenge to everyone involved. There is no recipe book to guide us. This type of development, based upon community learning and experimentation, is not a process that can be planned and managed, as we are accustomed to plan and manage our affairs. Every participant, and all of us collectively, will have to experiment with and learn from the process itself as we go along.

5

Plants and Soils: Liebig's Legacy and Beyond

> Modern man was limited by not knowing how things happened. When a background of knowledge had developed to the point where the question how? could be approached, further progress was possible. That progress was late, even in the period of recorded history – between 1800 and 1850.
>
> (Hendricks and Alexander, 1957)

As we become more and more aware of the environmental damage, social disruption, poverty and ill health being caused by modern chemical agriculture, we may well ask: where has this 'progress' led us; do we really know the 'how' of what happens in our soils when we grow crops? If our current theories of crop production were adequate we would not be encountering these adverse side effects. The optimism displayed in the above quotation is rapidly evaporating.

Chemical agriculture is indeed a legacy of the first half of the 19th century, a period when the science of modern chemistry was formulated in its essential features. The decisive application of this chemical science to agriculture was made by Justus von Liebig in 1840 when he propounded his theory of plant nutrition in terms of mineral elements taken up by growing plants from the

soil solution. We are today the inheritors of his way of thinking; it is second nature to us; we do not question it. It is time we did.

To question Liebig, and ourselves, effectively we must question the basic structure of present-day science. For the task is not one of considering the possibility that subsequent observations have invalidated Liebig's theory of plant nutrition. As far as we can see they have not. It seems unlikely that further research done within the same conceptual framework that produced Liebig's theory in the first place can disprove it (Box 5.1 *Theory shifts in science*). All we can say is that the theory is inadequate in view of the manifest unsustainability of modern agriculture. Our enquiry, therefore, will have to be into the conceptual framework underlying the theory. Before we can even begin, however, we need to see that metaphysical presuppositions, that is, *a priori* decisions about what we consider to be 'real', underlay all knowledge systems, including that we term 'modern science' (Box 5.2 *Some essential definitions*).

Liebig's legacy

To begin our enquiry let us briefly run through the key developments in agricultural science during the period 1800 to 2000.

During the three hundred years between 1500 and 1800 the materialist conception of nature slowly gained wide acceptance among European scientists. According to this conception the ultimate, real units of existence are minute, discrete, immutable particles of material substance or atoms. There are only a few dozen distinct types of atoms. The great variety of kinds of matter we observe in nature, each with distinctive properties, is a result of combinations of two or more kinds of atoms in larger aggregates, or of distinctive structural arrangements of several atoms of one or more types.

By 1800 the atomic conception of nature had almost completely replaced the Aristotelian conception which had reigned for more than a thousand years. According to this concept material substance was only of one kind. The apparent variety of kinds of matter we observe is caused by subtle 'forms' which organise this basic, amorphous matter into distinctive patterns. Thus there were as many 'forms' as there were kinds of matter. This was cumbersome.

Box 5.1.

Theory shifts in science

When phenomena are observed that cannot be explained by existing theory, the first reaction is understandably an attempt to extend or refine the theory so that it will explain these new observations. Saxena (1999) has advised us that: 'The time has come to rededicate ourselves to the essentials of Liebig's law of the minimum... Sustainable agriculture, therefore, must take into account all Liebig's nutrients, and must operate under Liebig's concept.' If this advice were to be followed, and Liebig's theory extended and refined to explain all the knowledge of soils, their structure and functioning, that has accrued since his time, it is just conceivable that an adequate theory of plant nutrition might be formulated. There is no doubt, however, that it would be immensely complicated, and hence cumbersome, requiring elaborate instrumentation and great computational power to implement. It would be practically impossible to apply it to the myriad conditions in which farming is carried out. A simpler more general theory which covers all possible conditions would be preferable.

In the history of science, of two competing theories, the simpler of the two has usually won out, even if the two were of equal explanatory power. One example of this was the adoption of the atomic theory of matter in the 18th century (see pages 100 – 101). Another was the replacement of Ptolemy's earth-centred theory of the solar system by the sun-centred theory of Copernicus in the 16th and 17th centuries.

Masanobu Fukuoka asks us: why all the expense and work of managing crop production when nature is perfectly capable of doing it for us – if only we get out of the way (Fukuoka, 1994). Albert Howard also demonstrated that 'crops look after themselves' if we do not interfere (Howard, 1940). The possibility of an alternative theory, both more effective, in terms of explaining observed phenomena, and simpler in practice does seem possible today. However, this alternative could only be part of an entirely new scientific paradigm, deriving from an entirely different view of the nature of reality.

The atomic view brought down the number of irreducible 'real' entities, as we have seen, to a few dozen only. This greater simplicity appealed to scientists. They decided to utilise the atomic concept in their further research. It is essential to note that the Aristotelian view was not disproved. 'Atoms' and

'forms' are both metaphysical constructs, presupposed as a basis for experimentation and theory formulation. They are neither true nor false, only more or less successful in practice.

Experimentation and theory formulation using the new atomic conception of matter were greatly facilitated by the work, at the end of the 18th century, of Antione Lavoisier. He formulated the law of the conservation of mass in chemical reactions by carefully weighing reactants and products, providing a powerful means by which the elements (basic types of atoms in the new paradigm) could be identified. (He had to perfect the chemical balance to be able to do this.) In 1803 John Dalton proposed a definite atomic theory in quantitative terms. This theory was elaborated throughout the 19th and 20th centuries. There was a further reduction in the number of fundamental 'real' entities to three - electrons, protons and neutrons. At the present time, in spite of the uncertainty about the 'real' nature of subatomic particles, the atomic conception of matter remains central to our way of looking at and thinking about the world.[1]

It was not long before the atomic theory of matter was applied to agriculture. Humphrey Davy was one of the first chemists to do this, offering an explanation of the value of manure and ashes in crop production. In 1813 he wrote:

> If the land be unproductive, and a system of ameliorating it is to be attempted, the sure method of obtaining the object is to determine the cause of its sterility, which must necessarily depend upon some defect in the constitution of the soil, and may easily be discovered by chemical analysis.
>
> (Quoted by Hendricks and Alexander, 1957)

Beginning in 1834, Boussingault – in combined field and laboratory experiments – attempted to account for the constituents of plants in relation to the composition of the soils in which they grew. Similar work was begun in 1842 by Lawes and Gilbert at Rothamstead Experiment Station - work which continues, more or less on the lines on which they began it, to the present day. The decisive experiments in the new paradigm, however, were done by Justus von Liebig. His conclusions were:

Box 5.2.

Some essential definitions

The term **worldview** denotes a coherent, logical constellation of speculative ideas about the structure and functioning of the universe that is shared by all members of a given culture. This constellation of general ideas forms, so to speak, the imaginative background of all thought in that culture, both in everyday living and in science.

Science is the purposeful, systematic study of phenomena, and the body of knowledge that accrues from such study. There are many ways of doing science, but how it is done – that is, what is observed, how it is observed, and what conclusions are drawn from the observations made – depends on the worldview of which it is an expression. The point of view here taken is that no one particular way only can be called 'science'

Law of nature is a statement describing relationships among given phenomena.

A **theory** or model is a speculative explanation of a given phenomenon, based upon the speculative ideas (or assumptions) of the prevailing worldview.

The term **metaphysics** is used for that branch of academic philosophy that identifies and explicates the ideas constituting a culture's worldview.

Speculative philosophy is that part of metaphysics which deals with the formulation of alternative ideas and their co-ordination to form a logical and coherent worldview adequate to the needs of the contemporary world situation.

The term **materialism** denotes the worldview in which the sole, ultimate reality of the universe is material particles in motion, acted upon by forces. Contemporary European science is, by and large, materialistic, but such a system of thought is not unique in human history. Rigorously logical systems of materialism were propounded in ancient Greece (the system attributed to Democrites) and in ancient India (the *Carvaka* and *Lokayata* systems – see Mittal, 1974, for a description), but these never gained general acceptance in their respective cultures.

1. 'The crops on a field diminish or increase in exact proportion to the diminution or increase of the mineral substances conveyed to them in manure.' (Quoted by Kellogg, 1957)

2. The watery extract of humus gave little or no residue on evaporation. On the assumption that plants take up mineral elements from the soil solution, humus is thus unimportant in plant nutrition since it is insoluble in water.

3. Of the minerals necessary for plant growth, the one present in the soil solution in the minimum amount, in relation to the plant's requirement, limits the plant's growth.

The attractive simplicity of Liebig's conclusions and his prestige as a scientist effectively demolished the entire structure of traditional knowledge of soil and crop management. They pointedly discredited the prevailing humus theory that plants feed on humus.[2] Henceforth soils would be viewed as '...static lifeless storage bins filled with pulverised rocks, which held water and nutrients, and which farmers stirred in tillage' (Kellogg, 1957). In spite of elaborations and refinements (in the fields of soil chemistry, physics, biology and morphology) over the following century and a half, this simplistic 'storage-bin' model has survived. It has underpinned the green revolution as evidenced by the 'package of practices' folders on crop production distributed by our agricultural universities beginning from about 1970.[3]

Some questions

To gain an in-depth understanding of this 'storage-bin' model, and of why it is proving inadequate, we need to ask several searching questions. These questions must be asked about the most general ideas, or primary assumptions of the worldview of contemporary global culture (see Box 5.2. Some essential definitions).

What is matter?

Twentieth-century physicists have found that, on exhaustive analysis of discrete 'physical' entities, nothing corresponding to the classical concept of matter remains. But long before this, many philosophers argued that the concept of matter as enduring particles of material substance is logically untenable. If we assume the existence of discrete, substantial, enduring, autonomous entities, it follows that they should possess attributes by which each one can be distinguished from all the others. The least ambiguous of these are the

physical attributes of mass, shape, size or volume, density, velocity and acceleration. A. N. Whitehead has pointed out that these are not attributes of individual entities, but refer to the relationships in a system (Whitehead, 1929, p. 309). Viewed in isolation from other entities material particles cannot be defined at all; they cannot, therefore, be said to exist.

This conclusion raises a number of questions. If there are really no enduring, substantial entities, then how do we account for our experience that there are things of some kind? Or at least there appear to be things. What is the nature of these appearances. Are they real?

Force

Another fundamental question that demands our attention is: what causes the appearances or things to come together to form the larger, more complex things such as molecules, crystals, cells, organisms, ecosystems, solar systems, galaxies that are parts of everyday experience. Or, in other words, what causes individual things to behave as they do in relation to other things?

Isaac Newton's explanation is the concept of force. In general this is a notion based on the analogy of pushing and pulling. More formally it is defined as the product of mass and acceleration of a thing in interaction with another thing: $F = M \times A$. Acceleration is a measurable entity: a change in velocity. Mass cannot be defined formally. It is simply an 'intuitive idea of how much matter there is in an object (htpp://en.wikipedia.org/wiki/Mass, consulted on 26/10/08).' If, however, there are no enduring substantial entities, then the concept of mass is not tenable, nor that of force, which is a derivative of it.

Newton's concept of force was developed as an explanation of the movements of planets in the solar system in relation to each other. In theory the forces of the various participants in the system, and those of other, more distant entities outside the system, can account for its structure. In practice it is impossible to capture the totality of these interactions in any single, determinant expression.

After Newton the concept of gravitational force was extended to terrestrial mechanics, and later still to an explanation of the interactions of basic material particles, though for this latter it was necessary to postulate three other types of force in addition to gravity. This line of reasoning was then extended to still

more complex organisations, and ultimately to living organisms. This is seen as a logical necessity given the initial premise that only atoms (now sub-atomic particles) are real entities. Thus cells, organs, microorganisms, plants and animals are not real entities in themselves, but only collections of elementary particles organised solely by the mutual interaction of forces. The forces are attributes of the parts, not of the whole.

The analogy for this conception is the man-made machine. A machine is absolutely predictable in its functioning. A machine-like universe operates according to laws that have been described by the science of classical Newtonian mechanics. Further, the performance of a machine can be altered in a predictable way by changing a part – a bigger gear here, or a more highly-machined bearing there.

In practice, the machine analogy is difficult to sustain in view of the discovery of the ultimately unpredictable nature of complex systems (see, for example, Goodwin, 2003). Further, there is the spontaneous emergence in these complex material aggregates of the phenomenon we term 'life'. How can life spontaneously emerge from a collection of supposedly 'dead' material particles? Further questions also come to mind. As we move from a consideration of plants, to animals and to human beings, there appears to be an increase in intelligence. Returning down the scale, so to speak, is it possible that material particles are entirely devoid of intelligence? Might not the tendency of atoms, or of planets, to form structures be the result of each knowing the pattern in which it is to participate, and an ability to act on it? It is this possibility I have in mind in using the term 'intelligence'. This explanation could also imply *a priori* shared knowledge of the patterns to be formed, in the same way each member of a team knows beforehand what the purpose and functions of the team are and hence his or her role in it. If there is rudimentary intelligence, must we not say that material particles are also living entities? If they are living entities, is the machine analogy valid?

The observer

Another characteristic of the contemporary European worldview from which modern science arises is a metaphysical dualism between mind and

matter. According to the seventeenth-century philosopher Rene Descartes the world 'out there' is an objective, self-existing reality, and I who observe it and interact with it am another, entirely separate order of reality. From this arose the notion of objective, impartial scientific observation of the natural world 'as it really is'.

There are problems with this concept. The 'I' who observes must be identified with the mind, since the body is obviously material. But what is 'mind'? To be consistent the materialist scientist should presumably consider mind, like life and intelligence, to be an epiphenomenon of certain complex material structures, in this case a brain. If that were so, it follows that mind comes into being with the birth of the body and perishes with its death. In what sense then is mind a 'real' entity? Anything real must be permanent, enduring forever – at least within the framework of the universe as we perceive/ conceive it – as is the case for material atoms. Mind seems to come and go, like life. More importantly, if mind is an epiphenomenon of matter, and we define ourselves essentially as mind, then how can 'I' be an independent observer of the world of which I am one feature? Is what the observer sees a single objective world, the same for everyone, or does what he or she perceives depend, at least in part, upon his or her body – its constitution and state of health – his or her local physical environment, the family and society of which he or she is a part and which shape his or her attitudes and determine what he or she thinks 'the world out there' is really like?

Beyond Liebig and the storage-bin paradigm

The foregoing brief excursion into the most basic metaphysical assumptions underlying the model of contemporary global culture highlights the tentative, speculative nature of the atomic-materialist worldview. This perception should lead us to see that no system of thought, or worldview, is 'true'. All systems are only tentative, fallible structures we put together to help us make sense of and cope with our experience. There have been other structures in the past, some still existent and not by any means untrue or useless, and there will be others in the future, such as the new holistic, ecological worldview that currently appears to be taking shape. The comings and goings of these structures depends ultimately on their success in practice. The contemporary science paradigm is

proving spectacularly unsuccessful, judging by the problems being encountered in chemical agriculture, to name just one area of human activity. We must learn to question all structures and evaluate them in terms of their practical consequences. This is what we are trying to do in this chapter.

Today a number of intellectual currents seem to be flowing together to form a new worldview, one that offers the possibility of resolving some of the problems of the contemporary materialist view, and which promises the possibility of sustainable living in general, and sustainable agriculture in particular. In this section we consider the most important of these.

A traditional view

There is a growing interest in the knowledge systems (that is, sciences) and practices of traditional societies the world over, as evidenced, for example, by a collection of essays edited by Haverkort and Hiemstra (1999), the papers in the *Asian Agri-History Journal,* and the Southern African Journal of Environmental Education. It is becoming clear that many of the ideas now coming to the fore, some of which we discuss below, are reformulations of traditional ideas.

The rural people of Uttarakhand with whom I have talked over the years hold to the traditional concept that plants feed on compost. They maintain that soils must be 'fed' with compost to ensure their health. Only healthy soils can produce healthy crops and nourishing food. A colleague of mine, a woman with a modern education (not in science or agriculture) and with strong roots in her own village, expressed the traditional view in somewhat different terms when she said 'compost contains *tattvas* which are passed on to growing plants (Champa Joshi, personal conversation).' *Tattva* is a Sanskrit word, also used in modern Indian languages, meaning the 'essence of a thing'. The idea is thus that something essential is passed on from dead plants to live ones to enable them to grow. The possibility of treating the *tattvas* as subjects for investigation after the fashion of modern chemical science, does not appear to have occurred to these farmers. Their attention is focused instead on the natural cyclical process by which life is renewed through death and decay. Their science might be said to consist in recognising this process in nature, and of devising means of facilitating it in their farming activities.

In my reading too I have come across a number of references to the perception among traditional farming people of the cyclical nature of crop production. About the *jhum* cultivators of New Guinea, for example, Rappaport (1976) has written:

> They comprehend more clearly than... modern men the circular structure of their world, and they are likely to understand well that their own purposes or goals are limited by that circular structure and the need to maintain it... Not only are gardens (that is, *jhum* plots) and forests, in their view, merely different phases in the same cycles, so are growth and decay, for young plants grow out of the decomposition of older ones.

This idea of circularity in natural processes sounds the defining note of the emerging ecological or systems theory of agriculture. It is towards a description of this theory that we are working. A process which is cyclical and self-sustaining is a system.

Micro- and macro-explanations

In the atomic materialist worldview the 'real' nature of phenomena is explained in terms of its micro-structure, that is, by the types and dispositions of the elementary entities of which it is composed. Rom Harre, the philosopher of science, whose terms micro- and macro-explanations I use here, points out that there is no inevitability about micro-explanations. There are other ways of explaining the nature of actual entities, whether these are material objects or activities. Macro-explanations are not only feasible, but are already accepted in certain areas of present-day life and science. A macro-explanation defines the essential, or 'real', nature of an entity in terms of its place and function as a part of a whole. For example:

> The duties of the chairman are explained by reference to the powers and functions of the committee which is a collection of members, including the chairman. 'The chairman has a casting vote in order to prevent deadlocks', is a macro-explanation of his special voting power since it is the committee that fails to come to a decision, not any individual members of it.
>
> (Harre, 1972, p. 146)

In the science of ecology, an organism of a particular species is explained in terms of its role in the structure and functioning of the ecosystem of which it is a part. In the absence of an ecosystem it could not live; it would have no meaning; in itself it has no 'real' existence.[4]

This type of explanation offers us an alternative way of looking at plant growth and crop production, among other phenomena, one which, I will argue, holds out the possibility of avoiding the problems (land degradation, falling crop yields and pollution) created in agriculture by our adherence to an atomic micro-explanation of all phenomena.

Unpredictable machines

From the results of experiments done by physicists during the first half of the 20th century, it now appears that the universe is not entirely deterministic as is assumed in the orthodox materialist view. The behaviour of individual sub-atomic particles has been found to be unpredictable as also the behaviour of large systems like global weather. The course of the evolution of living systems is also not predictable.[5]

Nevertheless, a large number of individual subatomic particles taken together do exhibit a predictable pattern of activity. Are the movements of the individuals really random? If so, how do we explain the emergence of stable structures like cells and plants? Yet further findings suggest that the particles in a given system share knowledge of the overall pattern and so 'know' the role they are to play in it. How can 'dead' particles 'know' anything? Whence the 'knowledge' of the patterns in which they participate? The notion of a machine-like universe seems to be unravelling, but nothing has so far emerged to replace it.

Some more about the 'observer'

The notion of two independent orders of reality, an objectively self-existent material world and an 'I' that observes it, is, as we have seen, a very dubious assumption. In the study of sub-atomic particles, 20th-century physicists found that observed phenomena and the observer are apparently not independent; what the scientist 'sees' is modified by his very act of seeing (Capra, 1997). This suggests that the alternative assumption – that the 'world' includes the

empirical 'I', body and mind - would be more appropriate. The implications of this are very great for the way we do scientific research and for the technology that comes out of it. If the empirical 'I' is not separate from the world 'out there', then I cannot manipulate the world 'out there' without manipulating 'myself'. If I poison insects, I end up poisoning myself. The notion of 'pest control' derives from the same paradigm thinking that has produced the storage-bin model of crop production. How many 'side-effects' directly injurious to ourselves can be traced to the use of chemical fertilisers, pesticides and the myriad other chemicals that are daily manufactured and released into the environment?

General systems theory

Our enquiry is slowly, and from several directions, coming to a focus on systems. Earlier the term system was defined as a process that is cyclical and self-sustaining. To be self-sustaining, a system must be able to take in energy from the environment and to dissipate excess entropy[6] to the environment. Systems do not come to rest, or reach equilibrium; they are dynamic entities that can evolve into more complex forms under suitable conditions, or can be forced to regress to simpler forms under unsuitable conditions.

According to Haigh (2000), in general systems theory all open systems share four invariant properties.

1. They evolve, they self-create and self-organise in an environment that offers an appropriate supply of energy.
2. They separate themselves from the environment, establish an identity that allows them to be recognised, and they persist in a changing environment.
3. As dynamic entities, they respond to changes in their environment and, as their complexity increases, they develop internal feedback mechanisms that insulate them from changes in their environment.
4. They are hierarchical structures. They are constructed from nested layers of components, subordinate subsystems, also called 'holons'. The term holon is used to describe an open system viewed as part of a hierarchy of

systems operating at different scales. Each system also acts as a holon component within larger order system structures which influence and constrain its activities.

In terms of this theory, all living entities are systems, as are their organs and cells, and the larger structures in which they participate such as ecosystems. Certain chemical reactions also form systems if a constant supply of energy is available, and entropy can be dissipated (Jantsch, 1980). An entity is a system '...if you can name it, identify boundaries that divide it from its environment, identify it as a functioning slice of reality, and if it is a wholeness in its own right (Haigh, 2000).' For our purposes a crop plant may be considered a system, nested in a series of systems of larger size (fields, farms, villages, and so on) and itself composed of a nest of smaller systems (organs, cells, molecules, atoms, and so on). All those systems larger than the plant, up to and including the whole earth, will be termed ecosystems.

In Figure 5.1 an attempt has been made to depict two ecosystems, land (in which individual fields and village forest are lumped together) and village, abstracted from the middle range of nested systems just mentioned. The predominant organising theme is energy flow, though flows of minerals are generally concurrent with these, and flows of gases and water are also broadly indicated. To do this a high degree of simplification has been necessary because of lack of space, and also because it is impossible to grasp, let alone depict, ecosystems in all their detail and complexity. Nevertheless, the diagram should at least indicate that in agriculture we are working with systems that display all the features listed above for general systems. Hopefully it will also suggest that attention to the integrity of these systems is the basis of sustainable agriculture. We will look into the concept of ecosystem integrity after completing our description of the village ecosystem.

The role of human beings in the village ecosystem needs to be spelled out (refer back to Figure 1.1). There are two levels at which people interact with the other components of the system. In the first place they consume food, oxygen and water, produce waste and do physical work within the system, like their domestic animals. The work they do, however, is intentional, that is, thought out beforehand with a definite end in view. In other words, they

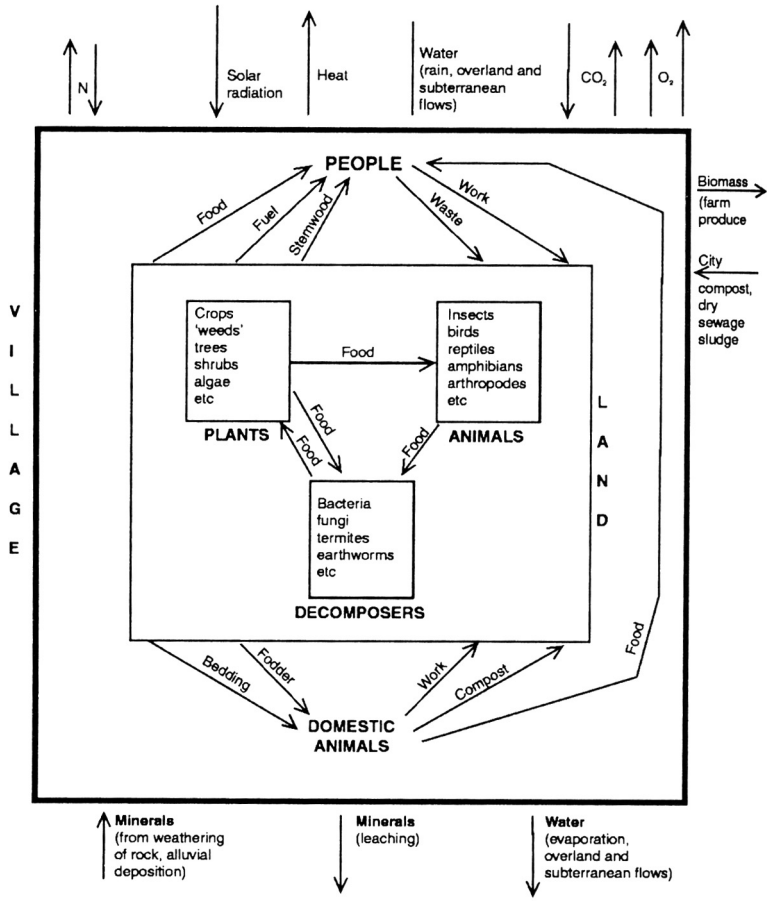


Figure 5.1. A schematic diagram of land and village ecosystems. The village ecosystem (enclosed by heavy lines) consists of three main elements - land (cultivated fields, rough field margins and village forests), domestic animals and people. Arrows show flows of energy/ minerals/ water/ gases. The contained land ecosystem consists of three elements - plants, animals and decomposers - linked by energy/ mineral flows.

manage the ecosystem in which they operate. Further, they create the village ecosystem by modifying a naturally-evolved ecosystem in which there are no human beings. These management activities are an expression of the collective attitudes, values and knowledge of the village society. We must recognise, therefore, a co-extensive, subtle human social system, which is also a system in its own right in terms of the four definitions given above, as a component

of the village ecosystem. Where the modern world has intruded, the traditional culture is stressed and distorted, and this causes a distortion of the co-extensive physical system, giving rise to a condition termed 'environmental degradation'.

The concept of system integrity is central to the alternative model of farming being described here. Every system consists of a number of processes by which subsystems (or holons) interact with each other. The dominant feature of these processes is the conversion of one substance to another; in ecosystems, this takes the form of food webs. The rates at which these processes occur are mutually controlled by the development of feedback loops mentioned in point three above. If the rate of any one reaction changes due to a temporary influence from outside the system, the rates of all the others will change. The initial perturbation will, however, be damped down and the system will tend towards the steady-state situation obtaining before the perturbation; in the terminology of definition 3 it is well 'insulated'. The integrity, or 'health', of a system, therefore, refers to this capacity to maintain its essential form in the face of external influences. For an ecosystem, 'health' denotes the continuance of the configuration of species/ communities characteristic of its climax or mature form. Severe and/ or prolonged external pressures on the system can cause it to regress to simpler, less mature, less stable forms. A cessation of the external pressure will allow the system slowly to recover its original, mature form; ecosystems evolve (definition 1) and a degraded ecosystem re-evolves, if external pressures are removed, along the same track it took in its initial evolution. However, if the pressure is continued, the system regresses to a point where it entirely loses it ability to recover. An example is the conversion of a forest ecosystem into a desert by faulty agricultural practices.

The stability or health of a village ecosystem, which is a modified natural ecosystem, requires the residents to understand its original form and functioning, and to imitate these as far as is possible in order to maintain its health and to ensure sustainable production. They must understand the information feedback the system provides in the form of distress symptoms[7] and act on this information to avoid ecosystem ill health and collapse. This is a more explicit and detailed statement of the rationale for Howard's advice to farm as Nature does (Chapter3).

From the systems point of view, most of our farming ecosystems – that is, our fields and villages – are sick, a few of them mortally so, owing to pressures put on them that they cannot bear. These pressures are the neglect of our village forests, the imperfect recycling of organic matter, the use of chemical fertilisers and pesticides, a failure to keep the soil surface covered, and the mono-culturing of species/ varieties of crops that are not adapted to the system. To restore these systems to health these pressures must be removed and then reliance placed on the systems' inherent capacity to heal themselves. More and stronger chemicals and synthetic genotypes will only make them more sick. The challenge is essentially the same as faces orthodox medical doctors seeking to treat cancer. They see cancer as a diseased part to be cut out, burned (radiation) or poisoned (chemotherapy), rather than a diseased body of which the malignancy is a symptom. The only adequate treatment consists in allowing/helping the body itself to regain its health. Further, the sick person's local environment is also diseased, having been stressed by, among other things, agricultural chemicals, which is often the real cause of the person's cancer. The treatment of cancer involves first of all, healing the local ecosystem.

To ensure ecosystem integrity, we must be aware of and abide by ecosystem constraints. The behaviour of the individual plant is 'influenced and constrained' by the next higher system in which it is embedded – the field ecosystem. This in turn is influenced and constrained by the village ecosystem, and so on. Thus in a field on a slope where soil texture is naturally coarser than in fields in level lowlands, yield will be constrained by low water- and nutrient-holding capacity. The field, in a village in the mountains, may be on a north-facing slope that is relatively cold and damp. This constrains the choice of plant species or varieties and also influences plant growth and yield for all fields in the village. At the next level, that of the regional ecosystem, let us say that the soil is formed from sedimentary rock; this further defines the cropping possibilities and yield potentials for a whole region. On a continental scale, climate is a constraint (for example, a monsoon climate) and finally the global ecosystem constrains our choices; for example, global warming in the next few decades may force worldwide changes in the types of crops that can be grown, how they are grown, and what yields they give.

We can also say that the health, growth and yields of crops are determined by the health of the field ecosystem in the first instance, and in turn by the larger systems in which the field itself is nested.

From the point of view of systems theory, therefore, agricultural science becomes a study of systems (field ecosystems, village ecosystems, and on up to the global ecosystem), their structure and functioning, and the construction of macro-explanations. Thus a particular species of insect (which might be termed a 'pest' at present) would be described in terms of its field ecosystem role; if its population becomes unusually large and damage to crop plants unusually high, we would see this as an indicator of an unhealthy field ecosystem. Other current 'problems', such as metabolic imbalances in individual crop plants, or unusually high 'weed' populations, would also indicate poor field ecosystem health. Agricultural technology in the systems paradigm consists of methods of modifying/ influencing systems at a level higher to the one in which the immediate problem appears. The objective of such technology is to improve ecosystem health. Examples are: a reduction in soil erosion, a plugging of leakages in organic matter recycling from the field and village ecosystems,[8] changes in crop rotations/ mixtures, a narrowing of the ratio of areas of crop plants to trees within the field and village ecosystems and improving existing village forests.

Ecosystems farming

The concept of systems constraints gives rise to a fundamental difference between the storage-bin and systems models of farming. The former, in general, does not recognise natural constraints. With sufficiently potent chemicals and a few 'improved' genotypes, uniform crops can be grown over a whole continent, or so the thinking of the green revolution scientist, farmer and agri-business executive goes.[9] The attempt is made to modify, to control, to dominate natural processes. As a result, technology based on this model is violent. It seeks to influence a single entity or process without understanding the system in which it is embedded, and therefore upsets the delicate web of interrelationships and mutual dependencies producing many unexpected 'side effects' and eventually impairing or even destroying the system.

The systems farmer, on the other hand accepts the natural ecosystem in which he or she finds herself - with all its constraints and opportunities. He or she recognises varying soil types and knows which crops may be grown to advantage in each. He or she pays attention to keeping the soil surface covered at all times, to recycling all organic matter and to the growing of trees as well as crops. In other words, he or she strives to understand and to imitate natural systems processes so that his or her activities do not stress the ecosystem. He or she sees himself or herself, his or her family and community as constituent parts of the ecosystem. Systems farming holds out the possibility of sustainable production, storage-bin model farming does not.

According to the storage-bin model there are areas that naturally have a low availability of a particular mineral and therefore give poor yields of the crops we want to grow and in the way we want to grow them. For example, the alluvial soils of Uttar Pradesh and Bihar in India are generally said to be 'deficient in phosphorus' (ICAR, 1980). Looking at such areas from a systems viewpoint, it would be noted that they were covered with dense natural forest for millions of years. No mineral 'deficiencies' were evident then. For every soil type, adapted species of plants have evolved. In the natural vegetation of an area that is, to our way of thinking, deficient in an essential mineral element, species with low requirements of that mineral have evolved. Species with a special ability to extract that mineral, accumulate it and return it to the surface soil in a more available form for future generations of plants to use will also have evolved in that area. In attempting to farm these sites we must learn from nature how to use these species, and to select crop species that do relatively well in soils with such 'deficiencies'.

Tropical rainforest soils are an extreme case of mineral 'deficiency'. Rainforests are the most productive (in terms of tonnes of biomass produced ha^{-1} $year^{-1}$) ecosystems in the world. These soils are highly weathered and leached. They possess almost no nutrient-holding capacity. As a result all plant nutrients are 'deficient'. The concentration of soil phosphorus in the Amazon rainforest, for example, was found to be only about 0.01 ppm (Bourguignon, 1996), equivalent to about 5 kg ha^{-1} in the upper 50 cm layer of the soil profile. On

the same sites, the living plant tissue and decomposing surface litter were found to contain 600 kg per ha of phosphorus. The uptake of minerals by growing plants in a tropical rainforest is from the surface litter through an extensive mat of surface roots. Minerals, by and large, do not enter the soil. Those that do are recovered by tree roots. When storage-bin model farming is taken up in rainforests the trees are cut down and burnt. The minerals they contain are quickly leached. Added fertilisers are also rapidly leached. Soil biodiversity is drastically reduced, leading to soil consolidation, rainfall runoff and soil erosion. This farming approach creates deserts in 4-5 years (Mann, 1987). In the ecosystems farming approach the original trees are not all removed. Useful perennials and a succession of mixtures of annuals are intercropped without disturbing the soil or uncovering it. All biomass produced by the system is returned to the soil surface as mulch. This approach disturbs as little as possible the circulation of minerals that characterises the original ecosystem, effectively preventing leakages. 'Deficiencies' do not occur. Traditional Javanese multi-storeyed gardens (Freeman and Fricke, 1984) approach this ideal very closely.

The question also arises: what to do with soils that have been worn out (that is, crops exhibiting mineral deficiency symptoms), degraded (for example, eroded, salinised) or killed by chemicals (that is, soils with low biodiversity)? The only certain way to rehabilitate them is to adopt a thoroughgoing systems approach to the problem by enlisting the help of natural processes. We can assist these processes by changing cropping patterns and species or varieties of crops, introducing mixed cropping if monocultures were being followed, incorporating shrubs and trees in the system, encouraging 'weedy' field margins, allowing marginal areas in the system to 'go wild', attending to biomass recycling and to keeping the soil surface covered. Where erosion has been severe, these measures may need to be augmented by constructing gully plugs and contour bunds. Saline and alkali soils are a result of a disturbance of the natural water balance of a field or village ecosystem, and this must be put right by better control of water application, providing drainage, if possible, or changing to less water-demanding crops if this is not possible, and the growing of saline/alkali tolerant crops, at least during the recovery period.[10]

A deeper look at systems theory

The emerging systems theory of agriculture continues to adhere to the assumption that ultimate reality is enduring, substantial material objects. At the same time, however, it is tentatively introducing the concept that life, somehow, controls the organisation and functioning of material systems. For example, Haigh (2000) explicitly discusses this possibility in his university level study unit entitled 'The Living Earth: an Introduction to Gaia and Geophysiology'.[11] Increasingly life is being seen as organising matter rather than as arising out of material structures. Systems theory is therefore introducing incoherence in the existing materialist worldview; that is, it is introducing a contradictory assumption. This incoherence will have to be removed if the systems theory is to be a fruitful conceptual framework for scientific study and sustainable natural resources management. This does not appear possible within the prevailing materialist worldview.

A consideration of the historical background to this development is instructive.[12] Present-day science, in its essential features, has been created by mathematical physicists, beginning with the work of Galileo in the 17th century and extending up to Einstein in the 20th. Its defining concept is material objects in motion acted upon by forces. But this concept is derived from only one part of the totality of human experience – that of the physical universe. So great has been its success in creating a machine culture, however, that it has, in the minds of everyone, become the ultimate explanation for all phenomena.

Biologists had few great concepts comparable with Galileo's concept of uniform motion (expressed in Newton's first law of motion) and Newton's concept of force, and the few original ideas they did have did not establish themselves in the prevailing climate of materialistic explanations. Without ideas, you cannot construct theories, and biologists did not come up with any explanation of life or intelligence. They were for the most part content to describe and classify, and to accept explanations deriving from the materialist view, however far-fetched these were. When Darwin formulated his theory of the evolution of life forms, he did so in materialistic terms of random variations and natural selection. Finally, however, a challenge to the materialist, mechanistic view of

the mathematical physicists is now coming from biology in the shape of the concept that the fundamental units of nature are living systems. This challenge has become more urgent at the present time because of the failure of materialist science in the field of natural resources management, most notably in agriculture.

Added to this is the fact that during the 20th century some of the experimental findings in physics itself also challenge the basic assumptions of materialist science as we have already seen. The stage seems set, therefore, for the emergence of a new view that will explain more adequately both matter and life.

The general concept of living systems could be the starting point for the development of a comprehensive, coherent worldview in which these systems would be seen as intelligible. For this to happen, however, an attempt will have to be made to define the concept of life, that is, life in its own right, as a real entity. As we have seen, a hint of such a definition is already appearing in scientific literature: life is what organises, impels and controls systems. Similarly, an alternative conception of causation to that which now prevails will have to be formulated. And here, too, tentative formulations are being to appear (see, for example, Selby, 2002).

To get down to work, then, I offer the following propositions as explicit statements of basic assumptions underlying the new worldview.

The ultimate and sole reality is the timeless, space-less Ground of all existence. It has no attributes and so cannot be described except negatively. It was termed 'That which is' by Parmenides, 'The One' by Plotinus, '*Brahman*' by the Advaita Vedanta philosophers, and '*sunya*' by Mahayana Buddhist philosophers. It is content-less and yet, inexplicably, it contains 'within' itself the potential for all manifest existence. This potential consists of a latent duality of subject and object. The appearance of manifest entities is the actualisation of this potential.

The manifest entities that appear are momentary experiences of things. They appear suddenly in the present and then immediately recede into the past where they continue to exist as subtle *karmic* traces. These traces are selectively gathered up and processed to create further experiences. This is

an elaboration of the Hinayana Buddhist concept of momentary experiences termed *dharmas*.

Aside from these momentary experiences in the now and their *karmic* traces in the past, there is nothing ('no thing') at all. In a series of experiences certain features are repeated so that, as in a motion picture, these repeated features take on the semblance of enduring entities such as atoms, cells, mountains, trees, people, ecosystems, galaxies, and so on. From these seemingly enduring entities, an extrapolation is made to give the concept of an enduring world 'out there'. Then the conclusion is reached that my experience is a faithful representation 'in here' of what actually exists 'out there'; more generally, the subject of the experience comes to see itself as an individual in 'the' world.

Life is the driving force and guiding presence of the recurring process by which experiences are created, In other words, it is what activates the potential for the experiencing of a thing. All things that appear in experience, at all levels of complexity, are thus living entities; they are organisms.

Time is the causal sequence of episodes of experiencing as also of the phases of the process whereby an experience is brought forth. Within an experience it is the sense of continuity of the present experience with those that have preceded it and which have entered into it as *karmic* influences that generates a sense of time. This in turn generates the expectation that further similar, though not identical, experiences will follow. The changes in the relative positions of various features of an experience in a series of experiences give rise to the sense of movement. Regular, repetitive 'movements' are the basis for the measurement of time.

Within an experience physical features are given extension and a set of extensive relationships. This is the work of space.

The orderly creation of units of experience and, once created, their mutual interactions, are governed by a single, common cosmic causal agency termed *Rta*. This is a dynamic, living system of causal law, ever-changing, ever-evolving.[13] It is imminent in every episode of experiencing, in the experiences they give rise to, and in the *karmic* traces that are left behind.

Within an experience the subject of all experiences, the subject pole of manifest existence identifies itself with a particular feature of the experience

and so seems to be in the experience and to participate in it. In conventional terminology it is, in human episode of experiencing, a 'person' - an observer or witness identified with the body of a homo sapiens.

Finally, the subject of the experience is said to know the experience. Aside from the experience nothing at all is known. Everything in an experience is known.

This brief description of the alternative worldview that is implied by the systems theory of science will have to suffice here. Those interested in a fuller description can turn to my book *A Return to the Perennial Questions: Fresh Answers for Our Times*. (Jackson, 2013).

Having thus defined the general determining principles of all that exists, we may need to remind ourselves, before we proceed, why we, down-to-earth, practical scientists, need to concern ourselves with such high abstractions. We have clearly entered the realm of metaphysics. Alfred North Whitehead, the 20th-century philosopher, has succinctly given us such a reminder.

> Metaphysics (or speculative philosophy) is the effort to frame a coherent, logical, necessary system of general ideas in terms of which every element of our experience can be interpreted.
>
> (Whitehead, 1929, p. 3)

Such a system of ideas is necessary because an inadequate system gives rise to flawed science, to avoidable problems in practice. I have endeavoured to show how this has happened in the case of present-day agriculture with the current materialist system of ideas. To construct a more adequate system we must make the effort to 'go back to first principles', or, in other words, go back to all the ideas on which our present worldview is based. Modern European (Enlightenment) science (unfortunately now also everyone's science) assumes that 'the' world is made up solely of self-existent, dead, material objects pushed and pulled about by external forces acting with mathematic exactitude. Indian Vedic philosophers assumed that all objects are living entities that are all intimately inter-related to one another. This assumption gives rise to the concept of living systems which provided the basis for a more adequate science. The proof of this is visible to this day in traditional Indian manufacturing processes,

medical treatment and farming. Indian technology is generally gentler, and, in the long-run, more effective (that is, more sustainable).[14]

Postscript

My basic contention in this chapter is that unless rural people in both GR and dryland areas of the country, scientists, agri-business executives and bureaucrats, indeed everyone, change the way we think, sustainable agriculture in the future will elude us. And, such change will have to be fundamental, at the level of our most basic assumptions about ourselves and the nature of 'the' world. A weight of opinion for a change in outlook is building up within the scientific community itself and among disillusioned people in all walks of life. But it is as yet far from the critical mass needed to bring about a decisive shift in worldview. Nevertheless, the history of human thought suggests that once a current of opposition to the status quo emerges, it slowly gains strength. In particular, a new worldview, with its derivative scientific theories, gains in strength when it is clearly articulated. I see this chapter as a contribution to this important task.

Notes

1. There is a tendency, arising out of long familiarity with a concept, to forget that it is a concept and not a concrete entity. Here is what we were taught at school, and what children are still taught. 'The existence of atoms is inferred by reasoning...all modern science is based on the atomic concept... Because the atom is such an abstract idea, it will be useful if we begin by analysing a problem where we can see, handle and weigh objects. The reasoning that we develop can be transferred to chemical phenomena even though we cannot see, handle, or weigh individual atoms (NCERT, 1988).'

2. Commenting a century later on the Liebig's dismissal of the humus theory, Howard (1940, pp. 144-5) wrote: 'According to this theory the plant fed on humus. Liebig believed he had shown that this view was untenable; humus was insoluble in water and therefore could not influence the soil solution. In all this he followed the science of the moment... It did not occur to him that while the humus theory, as then expressed, might be wrong, humus itself might be right.'

Howard was, of course arguing from the standpoint of a different scientific theory – that which provides the rationale for natural farming. In essence it is this theory that we are seeking to explicate in this chapter.

3. These folders invariably say that farmyard manure is to be applied as a basal dressing, but this is an empty formality. Has the green revolution technology increased the production of biomass that can be converted to farmyard manure? Even before the green revolution, application rates of farmyard manure were inadequate which, as I have argued in Chapter 1, was a symptom of a deteriorated farming system.

4. Compare this with Masanobu Fukuoka's comment (paraphrased in Chapter 2) that 'An object seen in isolation from the whole is not the real thing'.

5. As a non-physicist I have read only some of the popularisations of these findings. Good non-specialist accounts are given by Capra (1997) and Goodwin (2003).

6. Entropy is that part of the total energy of a system that cannot be directed to perform work. An example is the heat produced by living creatures as a result of metabolism.

7. The appearance in an ecosystem of a 'foreign' species of plant is an indicator of stress. Examples in Uttarakhand include the appearance in a natural oak (*Quercus* spp.) climax forest ecosystem of *chir* pine (*Pinus roxburghii*), and, in a *sal* (*Shora robusta*) forest climax, of lantana (*Lantana* spp). A shift of the *kurmula* beetle (*Anomal dimidiata, Holotrichia* spp.) from feeding on broad-leaved village forest trees to crop plants is also a symptom of stress (see Box 8.1. The kurmula grub). Muddy streams and rivers are yet another. Stress symptoms also occur in the village community; alcoholism was referred to in Box 1.1 *The kurmula grub*.

8. Leakages of biomass from the village ecosystem, when viewed in the larger context of a regional ecosystem, become a problem for the city as well as the village. Food and industrial biomass become urban garbage and sewage, creating a 'disposal' problem, while a shortage of biomass needed to maintain soil health becomes a rural problem. Solving either one in isolation is not possible. The biomass cycle from the village to the city and back to the village must be restored (Suman Pande, personal communication, 2004; see also Figure 5.1).

9. The mention of 'uniform crops...grown over a whole continent' points to the reason the storage-bin model of plant nutrition is propagated by industry. If agriculture is conceived of as a factory process, there is money to be made (at least in the short run) by machinery, chemical and seed companies, if not always by farmers. The systems model, on the other hand, removes the control of agriculture from the corporate sector and places it firmly in the hands of local ecosystem residents who have an interest in the health and long-term productivity of their system.

10. The restoration of alkali soils is a slow process even if all the measures mentioned are taken. To hasten it, the application of gypsum (calcium sulphate) is a standard recommendation. Calcium ions from the gypsum replace adsorbed sodium ions, allowing them to be flushed out. This is a technology based on a micro-explanation. As a one-time measure it may be advisable, just as with a cancerous tumour that is pressing a vital organ, surgery is helpful, even essential, to recovery. Thereafter, full, and permanent recovery must be sought in terms of systems healing.

11. The Gaia theory was first put forward by James Lovelock (Lovelock, 1979) as an explanation for the creation and maintenance of the conditions (temperature, composition of the atmosphere, salinity of the oceans) which make life possible on the earth in terms of the interdependent activities of living organisms, micro-organisms, plants and animals. The name Gaia is that of the ancient Greek Mother Goddess.

12. I owe this historical perspective to the 20th-century philosopher Alfred North Whitehead. In his book Science and the Modern World (Whitehead, 1925) he presents a critical historical analysis of the development of European science and points to a need for a complete revision of its entire conceptual basis. He also sketches his suggested alternative organic theory of nature. Later in 1929, he fully developed this theory in his book Process and Reality (Whitehead, 1929). Jantsch (1980) claims that Process and Reality has been influential in the development of the general systems theory.

13. The unpredictability of phenomena that is observed at an empirical level is thus only a superficial appearance. Every event - physical, mental, emotional and feeling - is strictly determined, according to this explanation, by the common cosmic causal agency, *Rta*.

14. Indian traditional technology is gentle because it has a local context. It is embedded in natural systems, the local ecosystem and the local community. It is therefore subject to the constraints imposed by those systems. Modern technology, in contrast, has no local context but only a global monetary context; such technology therefore overrides local system constraints and, indeed, destroys local systems altogether. It is violent. It seems to me that the concept of *Rta*, the order of nature, in the Rigveda gives recognition to the totality of constraints of natural systems and the necessity of abiding by them. Knowledge of this order is traditionally embodied in myth. All things are seen as living and therefore to be revered. A similar feeling of reverence for the planet earth is being evoked among many people in the West at the present time by the notion, arising from the Gaia theory, that the earth is a living entity (Sachs, 1999).

6

Progress - The Career of an Idea

The concept of progress is at the heart of the worldview of contemporary global culture. It is one of the most potent concepts in human history. We cannot hope to understand our contemporary world nor visualise a sustainable future for ourselves without an understanding of this concept.

A break with the past

The concept of progress is a child of the European so-called enlightenment (commonly spelled with a capital E). The thinkers of that period (the 17th and 18th centuries AD) saw themselves as making a decisive break with the past. They rejected the Aristotelian worldview of the medieval period (about 500 to 1500 AD) in favour of an materialistic-mechanistic view. They saw medieval European culture as a dark age of human ignorance and superstition to be wiped out by the 'light of reason'. The values in terms of which society is organised, instead of being derived from divine revelation, from the inspirations of prophets and sages and from the deepest intuitions of all ordinary people, were now to be formulated on the basis of rational thought based upon contemporary empirical evidence. After all the struggles of countless generations before them to secure unqualified human

well-being and happiness, they had finally found the formula. Human nature and the social system could be perfected by the 'light of reason'. Henceforth European civilisation could only proceed towards this happy state. Indeed, progress is inevitable.

Thus was the idea of progress born. The subsequent breathtaking achievements of materialistic science, the breakdown of the feudal system and the appearance of the theory of social Darwinism all reinforced this idea of progress. It became the driving force of European civilisation in spite of numerous critiques showing its basic assumptions to be untenable (Box 6.1, Critiques of the idea of progress), the reactionary romantic movement of the 19th century(1), two world wars and an ecological crisis in the 20th century.

Colonialism as progress

The force of the idea of progress was felt by the non-European world in the 18th and 19th centuries in the shape of colonialism. If Europeans looked upon their ancestors as primitive, but as moving inexorably, if unconsciously, towards their own enlightened state, then they naturally looked on the people of non-European cultures as 'contemporary ancestors' (Viswanathan, 1988). They would eventually, inevitably, become enlightened. And it was the moral duty of Europe to assist in their rapid progress towards this goal. In practice, of course, this project was profoundly self-serving, as Randhawa has written: 'The primary concern of the British rulers [in India] was to promote the commerce of their country in India (Randhawa, 1983, p. iii).' This they did by: 1) creating a railway system, the better to extract raw materials; 2) introducing cash crops (for export) and research into growing them; 3) levying land taxes, to be paid in cash to ensure the adoption of cash crop production; 4) alienating village forest land in the interest of state commercial forestry; 5) introducing an educational policy designed to educate and socialise a small Indian elite class into their worldview (Kumar, 1991, p. 24), along with a system of privileges for the those so educated and socialised.

Development - progress in a new incarnation

In mid-twentieth century, with the demise of colonialism, the concept of

Box 6.1.

Critiques of the idea of progress

The primary assumption on which the idea of progress is constructed is that with careful observation and a process of rational thought nature can be known 'as it really is'. The shortcomings of this assumption have been pointed out by many thinkers over the past three centuries.

Immanuel Kant, in his Critique of Pure Reason published in 1781 (Kant, 1934), showed that the scientific notion of the human mind as passively receiving sensations from which it constructs a picture of the outer world 'as it is' is untenable. In reality sensations are graded and ordered according to *a priori* concepts which are inherent in the working of the mind. His assumption was not that '…man's knowledge…conform[s] to objects, but that objects…conform to man's apparatus of knowing (Encyclopaedia Britannica, 1992 article on The History of Western Philosophy).'

The concept of rational, unbiased human thought received a severe setback in the 20th century. Sigmund Freud formulated theory of the unconscious that explains compulsive irrational human thinking in terms of painful childhood experiences that have been repressed (Freud, 1973). C. G. Jung developed a theory of a collective unconscious that is transpersonal and contains archetypal patterns that play an important, if not decisive, role in human thought and behaviour (Jung, 1956). (This theory of the collective unconscious, which constitutes a vast historical record, is a crucial support to the theory of universal intuitions put forth in Chapter 8).

J. K. Bajaj (in 1988) presented a powerful critique of Francis Bacon's methodology of inductive reasoning that is the primary dogma of modern science. He has shown, by reference to Bacon's own writings, that his method of inductive reasoning is not immune to bias due to the investigator's preconceived notions.

E. F. Schumacher in his book Small is Beautiful offered a powerful critique of the rationale of modern Western civilisation, or, in other words, of the Enlightenment worldview (Schumacher, 1974).

progress was recast as 'development' in order to allow the European (now 'Western' or 'Northern') powers to continue 'business as usual' in the South.

> …the image of 'development' is constructed as an infinite process of continuous improvement. Tomorrow's conditions, so the story goes, will always surpass today's conditions, if society is put in motion and managed in a rational way. 'Development', during the decades after the Second World War, was nothing other than a reincarnation of the late eighteenth-century idea of material progress, only now projected world-wide and considered attainable within a few decades through planning and engineering.
>
> (Sachs, 1999, pp. 164-5)

The colonial pattern has thus continued, indeed, intensified, in the South during the last half century. Local elites have continued to turn their backs on their own cultures, and to view the poor majorities in their own countries as 'contemporary ancestors', that is, people at a primitive stage of human evolution who must be helped to progress to the stage of modern global culture. If they resist, it is even justified to use force on them for their own good - and, of course, 'in the interest of development'. (See Box 6.2, *Andhra Pradesh farmers say 'no' to development*, for an example.)

In the 1990s a fresh wave of 'progress' rapidly gained momentum in the form of globalisation. We are assured by global business interests, Northern governments and international financial institutions, and increasingly by our own governments (in the South) that globalisation is simply inevitable. It is the next stage in the triumphant march of humanity towards universal well-being and happiness for all in the shape of a homogenous, consumerist, 'rational' global culture. A World Trade Organisation official talking about the new GATTs (General Agreement on Tariffs and Trade) legislation put it this way: 'Basically it won't stop until foreigners finally start to think like Americans, act like Americans, and, most of all, shop like Americans' (Resurgence magazine, number 206, May/ June 2001).'

The mounting environmental crisis, however, may finally bring the concept of progress to an end. The unsustainability and injustice of globalisation are being exposed by thoughtful observers in both the North and the South (see, for example, Berry, 1999 b; Goldsmith, 1999; and Shiva, 1999) - and resistance to it is increasing (Norberg-Hodge, 1999).

Box 6.2.

Andhra Pradesh farmers say 'no' to development

A current example of 'development' which marginalises rural people is the Andhra Pradesh government's agri-business model of export-oriented agriculture termed 'Vision 2020'. The programme will encourage farmers to switch from semi-arid zone staples - millets, sorghum and pulses - to genetically-modified cash crops - Bt cotton, golden rice and soyabeans. The millets and sorghum that do continue to be grown would be used as poultry feed and to produce industrial alcohol. A 600 square kilometre 'genome valley' is being planned where biotech companies such as Monsanto will be invited to carry out trials. The programme is being financed by the World Bank and the United Kingdom's Department for International Development.

Unlike in the past, however, this programme is being contested by the people who are to be 'developed' - the farmers of Andhra Pradesh. One hundred and forty farmers groups from all over the state have formed the Andhra Pradesh Coalition in Defense of Diversity (APDD). They point out that the Government's programme, if implemented, could further marginalise upto 20 million rural people - indeed, displace them from the land, with no provision for alternative livelihoods; that it would require a massive increase in irrigation (in a chronically drought-prone area); that it would in any case be useless, because Andhra Pradesh farmers could never compete with large, government-subsidised American farmers, and also because European consumers are reluctant to buy food from genetically-modified crops; and finally, that food and livelihood security would be jeopardised.

The APDD has issued a statement of their own vision of the future: local food and livelihood security and community control over local resources. They declared that Andhra Pradesh should 'maintain healthy soils, diverse crops, trees and livestock and build upon our indigenous knowledge, practical skills and local institutions.'

(Hines, 2001)

Nevertheless, the concept of progress/ development will not die easily. A major response to the environmental crisis is the concept of 'sustainable development'. This concept is still evolving, its definition at present is vague, and there is much evidence that the 'limits to growth' have still not, in fact, been accepted by those with a vested interest in conventional development.

A loss of anchorage and vision

There is a need to reflect on the evidence now available for the harm this idea is causing to a majority of the world's inhabitants, including sizable minorities in the North itself, in the form of economic hardship and insecurity, social disintegration, cultural alienation and ill health. Rajni Kothari has summed up this situation by writing: 'Today …the Western world is uneasy with its own Weltanschauung (worldview) and its imitators are uneasy with their loss of anchorage and vision (Kothari, 1990, p. 28).

A limited conception of progress

This rejection of the idea of progress does not mean that we do not recognise the refinement and extension of concepts and techniques at all. They do occur within a given cultural epoch. For example, Balkundi (1998) has ably demonstrated how the concept and practice of rainfall prediction gained in clarity and accuracy throughout a period of a thousand years or so - from the time of Parashar to that of Varahamihra - achieving ever-greater accuracy. What appears doubtful is the notion that progress can validly be applied across cultures and epochs within cultures.

More fundamentally, the purpose of this critique is to challenge the notion that our present-day worldview is the ultimate truth; that it has been arrived at by the exercise of objective reason; and that since our ancestors were borne down by tradition and superstition their reasoning was subjective and unreliable, thus preventing them from arriving at the truth. The view put forward here is that the Enlightenment belief in objective human reason is an illusion; there is no such thing (see the presentation of this argument by Bajaj, 1988). Reason struggles to conceptualise basic human intuitions, and the result is highly subjective to the cultural context of the thinkers. There is no objective standard worldview – ancient or modern – against which to evaluate worldviews in general. Vedic people did as best they could in their cultural and environmental context. We have the advantage, which they did not, of seeing how well their formulations worked in the succeeding centuries, and thus of seeing how the inadequacies of their formulations might be avoided by us. 'Learning by experience' of course happens, and is essential to our

individual and collective well-being. But it cannot happen if we assume, as thinkers of the European Enlightenment did, that the experience of earlier cultures is valueless, since it is based upon ignorance and superstition.

This limited conception of progress - that we can learn from the past, that we must learn from the past if we are to avoid going astray, fosters optimism about the future, even if considerably less extravagant than that of the Enlightenment thinkers.

Note

1. Wordsworth…in his whole being expresses a conscious reaction against the mentality of the eighteenth century. This mentality means nothing else than the acceptance of the scientific ideas at their full face value. Wordsworth was not bothered by any intellectual antagonism. What moved him was a moral repulsion. He felt that something had been left out, and that what had been left out comprised everything that was most important (Whitehead, 1925, p. 77).

The Vedic Worldview

Every culture in every age has a characteristic worldview. It is only from that point of view that we can understand that culture's mode of interaction with nature. In the study of the agricultural practices of the Vedic period we must, therefore, first acquaint ourselves with the Vedic worldview.

The term worldview denotes

> …a coherent, logical constellation of speculative ideas about the structure and functioning of the universe that is shared by all members of a given culture. This constellation of general ideas forms, so to speak, the imaginative background of all thought in that culture, both in everyday living and in science. (Chapter 4)

The worldview of contemporary global culture, largely defined in the philosophical and scientific works of the European Enlightenment, posits the ideas of: 1) material atoms in motion as the sole ultimate reality of the universe; 2) this leads to reductionism or the definition of all entities in terms of their constituent parts (that is, defining objects in terms of their constituent atoms); 3) mechanical determinism (Newton's law of universal gravitation is the model theory); 4) a duality of the observer and the observed

(which contradicts the idea of atoms as the sole ultimate reality of the universe); 6) the pursuit of pleasure as the highest aim of life.

The Vedic worldview posits an entirely different set of ideas: 1) a complex universe of many realms, emerging from and supported by an unmanifest, indescribable, unitary principle - the ultimate reality; 2) The universe as a whole, and all its constituent parts in all realms, are living beings; 3) The universe as a whole, and each of its parts, is governed by a single, all-embracing order, *Rta*; and 4) A person's primary duty is to understand the universal order and, in all life's activities, to help maintain it. These ideas are spelled out in the Vedas, particularly in the Rigveda. In Krishi-Parashara (Sadhale, 1999), a farming manual, it is also possible to infer these same ideas at work, as we shall see in a moment.

Not only are the worldviews of different cultures different, the manner in which they find expression also differs. Whereas we today use abstract word symbols, and even more abstract mathematical symbols, the ancients of all cultures, and traditional peoples even today, use the concrete symbols of myth. These symbols are animate entities, human beings, gods, demons, the subtle aspects of departed human beings, and animals, all endowed with human thoughts, emotions and abilities (though usually exaggerated in one direction or another). Natural phenomena – physical, mental, emotional and spiritual – are described in terms of stories enacted by these entities. Inanimate entities are also common symbols in myth, deriving their significance from their roles in particular stories. To understand the Vedic worldview we must be able to 'read' the concrete symbols of myth.[1]

The universe is large and complex, consisting of many realms

The Vedic world is much larger than ours, not in terms of kilometres or light years, but because, in addition to the physical realm on which modern people focus exclusively, it contains many subtle realms. Krishi-Parashara in verse 6 mentions three: 'Food is life, food is also strength, food is everything. The divines, the demons and the humans all live on food (Sadhale (1999).' This is a somewhat casual description. A more formal one is, to quote Swami Sharvananda (1958):

> …the rishis of the Rigveda looked upon the universe as possessed of three different strata or planes of existence: the topmost plane is called *dyulok* or celestial sphere; next comes the *antarikshaloka*, the sphere of intermediate space; the third is the *bhurloka* or terrestrial sphere. In these spheres there are three presiding deities: *Savitr* or *Surya* (Sun) is the god of the celestial world; *Indra* or *Vayu* (Air), is the god of the intermediate space; and *Agni* (Fire) is the god of the terrestrial region.

The middle region contains a variety of beings, some beneficent and some harmful. It includes the ancestors with whom it is essential for the living to maintain a relationship. People who die violently or for whom the post-funeral rites are not performed may become troublesome or even harmful to the living. These are one type of 'evil spirits' mentioned in verses 100 and 101 in Krishi-Parashara.

The mention of one or the other of the three presiding deities in prayers and hymns in the Rigveda serves to indicate the level with which the petitioner or singer (of hymns) seeks to interact.

The human being is considered to have a three-tier structure analogous to the cosmic structure just outlined. These three are the physical body, the subtle body composed of thoughts, feelings and emotions, and the causal body, the seat of individuality, the seed from which the human personality (*jiva*) sprouts. In the waking state we are aware of the physical body, in dream we are aware of the subtle body, but not the physical, while in deep sleep we are unaware of either the physical or subtle body, and yet we continue to exist. The 'I' that persists during deep sleep, although unknown to me at the time, is recognised as being a reflection of the ultimate, sole reality that utterly transcends the manifest universe, an intuition of which was sought to be expressed by the symbolism of the Sun (Rigveda verse 1:50:6, translated by Nene and Sadhale [1997]).[(2)]

The reasons for drawing this analogy are three. First, the physical body of the person is seen as generating the energy that powers the physical organism, and in addition the subtle energies that are the 'food' of the subtle bodies. Second, there are recognisable correspondences between the human person (the micro-cosmos) and the universal Person (the macro-cosmos). Finally, at death a person drops the physical body and finds himself or herself in the

subtle body in the middle realm of the cosmos. After a period there, which can be pleasant or unpleasant, the person takes physical birth again. A description of life in the middle realm (*Pitr-lok*, ruled by *Yama*) is given in Rigveda 9:1 13:7-11. The concept of rebirth is, according to Kunhan Raja (1958), suggested in the Rigveda, but is only made explicit in the Upanishads.

The grandest achievement of the Vedic age, however, is the realisation that, however one explains the universe, one is bound by it – bound by his or her own human personality. Mankind's ultimate urge is for freedom, and freedom is possible only by transcending personal identity.[3] In the Rigveda itself there is a clear indication of the concept of *Brahman*, the ultimate reality, the Source and Ground of all that exists, in the beautiful and much translated hymn 10:129, popularly termed the Hymn of Creation. This is the grand theme of the Upanishads. They also describe the means by which the identification of the I with an individual body may be transcended and realise its true identity as *Brahman*. One has only to realise the I's true identity as *Brahman* to be free. It is this latent possibility of becoming free that was referred to earlier as a 'reflection'. The concept of *Brahman* in relation to the person is described symbolically by the two birds in Rigveda verse 1:64:20.

To conclude, we may say, with Swami Sharvananda (1958), that the Vedic worldview provides guidance for attaining mundane welfare, including heavenly enjoyments after death, and for attaining ultimate freedom. It gave meaning and direction to human life. At present it still informs traditional Indian culture, and even for those of us educated in the Western tradition it tends to be the preferred interpretation of inner world experience. (In our public and professional lives we have taken on the concepts of the materialist worldview of global culture.)

We have now sketched the broad framework of the Vedic worldview. It remains to elaborate the additional key concepts that will complete the structure. These have been introduced in this section, or at least hinted at.

The universe is an organism

In the Vedic worldview the universe as a whole is seen as a living organism, and not, as in the modern worldview, a machine. In a living organism each of the parts (organs, tissues, cells, molecules, atoms, and so forth) contributes in

a unique way to the structure and functioning of the whole. The whole provides the parts with knowledge of the overall organisational pattern in which they participate to ensure their integrated functioning, that is, to ensure that all the parts are governed by the over-riding need to maintain the integrity and health of the whole. This broad analogy will facilitate an understanding of the functioning of the universe whose structure was described in the previous section.

The intuition that the universe is a single, all-inclusive living being is given expression in Rigveda verse 1:35:5.

> All beings, men and creatures, abide forever in the bosom of *Savitr* the divine.
>
> (Translated by Panikkar, 2001)

Even the more abstract conception of ultimate reality suggested in Rigveda verse 10:129:2 is of a living entity.

> Nor death was there, nor deathlessness, nor change of night and day. One breathed calmly, self-sustained. Naught else beyond it lay.
>
> (Translated by J. Muir, quoted by Mahadevan, 1958)

Not only is the whole universe a living being, but all its parts are living beings as well. The gods are not simply the rulers of their respective realms, but are those realms. The beautiful hymn to *Prithvi*, the Earth goddess (Atharveda 12:1, translated by Panikkar, 2001) leaves one in no doubt that the Earth is viewed as a living being. She is also addressed in the prayer at Krishi-Parashara 140 as 'Mother Earth' (Sadhale, 1999); she has a 'menstruation' period (Krishi-Parashara verse 175) (Sadhale, 1999); and is impregnated by the Father, the Sun (Rigveda 1:164:8) (Nene and Sadhale, 1997). The planets too are living beings, the *devas* (the shining ones) (Panikkar, 2001, p. 875).[4] The ploughed field is Sita (Rigveda 4:57:7, translated by Nene and Sadhale [1997]).

Other ancient cultures also saw the universe as a living being. Goldsmith, quoting a number of authorities, writes:

> Among the ancient Greeks…the Pythagoreans held that the 'world is spherical, animate, ensouled and intelligent'. Plato saw it as 'a living creature, one and indivisible, containing within itself all living creatures that are by nature akin to itself'.'
>
> (Goldsmith, 1998, p. 116)

In Krishi-Parashara, verse 6, we are told that the gods and other beings of the middle realm subsist on the food produced by human beings. Indeed, it is the farmer's duty to produce sufficient for his family, for the gods and 'departed souls' (Krishi-Parashara, verse 98) (Sadhale, 1999). Human beings thus have an indispensable role to play in the maintenance of this realm (that is, feeding themselves, guests, the poor, and religious mendicants) and also in the maintenance of the middle realm. This is accomplished by the numerous food-offering ceremonies. The feeding of guests, of the poor and mendicants is seen as an offering. Offerings to the gods and ancestors are mediated by *Agni*, the sacrificial fire who carries them upwards to the higher realms (Rigveda 1:1:1; Chaitanya, 2000) or offered more directly as at the Deepawali festival when puffed rice is thrown into the air for the spirits. In addition to food, ancestors obtain the moral support of the living in the *sraddha* ceremony. Troublesome spirits are often unhappy lonely deceased persons who can be helped by meeting their unfulfilled needs in various symbolic ways. Demons also get a share, though often by extortion, as in the story of the demon Balasura in the Mahabharata who terrorises the inhabitants of Ekachakra until killed by Bhima (Rajagopalachari, 1968).

The welfare of human beings, in turn, is dependent upon the gods. The gods are the source of all knowledge of the universe, including knowledge of the physical realm and right human conduct within that realm. They also have the power, within limits (see next section), of disposing events on the physical level, such as rainfall, harvests and health, in ways beneficial to human beings, and can be petitioned to do so with appropriate prayers and sacrifices.

It is vitally important to keep the subtle channels of communication between the gods and human beings open so that knowledge can flow downwards from the gods. This flow is sometimes shut off by the selfish, greedy behaviour of demons, but can be reopened by petitioning the gods. Verses 1:32:12 and 1:11:5 in the Rigveda are considered to refer to this flow, represented symbolically by the resumed flow of the 'seven rivers' and the return of stolen cows. Water and cows are both symbolic of light or knowledge or wisdom (Apte, 1951; Kunhan Raja, 1958; Pande, 1990).[5] The demon Balasura who stole the cows, and the demon Vratra who stopped the flow of the rivers, can be read

as symbols of the selfish, greedy behaviour of people ignorant of the of the 'way of the universe', of *Rta* (see section '*Rta* – the cosmic order').

Everything in the Vedic universe is not only living, but is also sacred.[6] In the modern worldview, ultimate reality is 'dead' matter, and therefore plants, animals, micro-organisms and even human beings are not sacred and can be treated solely as resources to be used. It is widely argued that unless citizens of the global culture develop an adequate environmental ethic the current environmental crisis cannot be resolved, and that the basis of such an ethic is a sense of the sacredness of all that exists. But this sense cannot come to people unless they see life as real in its own right. The environmental crisis is thus a metaphysical crisis – a crisis in the modern worldview. Undoubtedly, the most important thing we can learn from a study of the Vedic worldview is this.

But what does it mean to say that life is sacred? Sacredness is a feeling, not a concept. How, or from where, does it arise? We can only say: from a sense of mystery – an inability to explain or even ultimately to understand in rational terms what life is. It will not do to say that the ancients lacked our present scientific knowledge and so fell back upon superstitious belief. Rather we must admit, as they did, that there is a limit to human reason. Our ordinary everyday experiences of life and matter defy rational comprehension (see Chapter 5). Admitting this humbles us and gives rise to a sense of awe in the face of the universal mystery of manifestation; awe and reverence are the very essence of the sacred.

Rta – the cosmic causal agency

We have said that the planets, as living beings, possess the power of self-movement. They are called the 'wanderers' because their positions continually change in relation to the 'fixed' stars. However, they are not free to go just anywhere; they do not stray outside the zodiac. It is the same with everything else in the Vedic universe. Everything is living and self-moving, yet all are guided and constrained in their activities by an overall, cosmic pattern of inter-relationships. That pattern is *Rta*. 'Firm-seated are the foundations of *Rta*. In its lovely forms are many beauties. By eternal law they give us long-

lasting nurture. By eternal law have the worlds entered the universal order (Rigveda 4:23:9, translated by Chaitanya, 2000). Even the gods are 'born in *Rta* and governed by it (Apte, 1951).'

The easiest way to understand this totality of patterned activities is to return to our analogy of a living organism. It is a dynamic entity, not like a blueprint, for it actively creates and sustains the manifest universe. It is what brings into being and maintains systems, as this term is defined in the systems theory that underpins the new or ecological science paradigm (Chapter 5).

A healthy animal maintains its structural and functional integrity, not in a rigid and mechanistic way, but in a fluid, flexible, adaptive way. If an organism is stressed by outside influences, it may be deformed temporarily, but when the stress is removed it regains its normal functioning. If the stress is continued, the species as a whole may gradually adapt to the stressful condition; in other words, the species evolves. Of course, there are limits of stress beyond which an organism cannot respond effectively and is therefore destroyed.

This concept of a system can serve as a starting point for understanding the Vedic concept of *Rta*, or cosmic causal agency. We must, however, enlarge the systems concept to accommodate it to a three-tiered Vedic cosmos. In other words, emotional, mental and spiritual energies, in addition to physical entities, are all factors in the cosmic flux of *Rta*. In growing a crop successfully, not only are the physical factors of planetary positions, soil, rainfall and hard work involved, but also the 'frame of mind' and purity of the farmer. Parashara (in Krishi-Parashara, verses 82 and 83, Sadhale, 1999) tells us that only a farmer who is motivated by the welfare of people, and who visits his crops daily can be successful. Jeyarajan (2000) reports that in the *Thirukkural*, a Tamil poem composed in 70 BC, it is stated that, 'If a farmer does not regularly visit his field the crop will not grow.' We all know people with 'green fingers', and also those in whose presence plants simply do not thrive.

It cannot be repeated too often that *Rta* is the manifestation of a living universal being. It is not an eternal, immutable blueprint, but a dynamic, evolving subtle pattern of relationships. The difficulty in grasping this concept is pointed out by G. C. Pande (1990, p. 25).

> It would be natural to seek the content of *Rta* but the quest would be doomed to failure because *Rta* is not accessible to intellectual reason and discursive speech. It is neither a single law or form nor any system of laws or forms. It is rather the ultimate presupposition of all specific types of order or systems of laws belonging to different realms of objects. It is the celestial matrix of terrestrial forms, itself not a limited form but a whole that is self-determined and self-expressive in infinite variety.

This has important implications for us who are seeking to re-establish a connection with the past in order to consciously shape our future. It is a great mistake to seek to re-establish today, either in science or in society, the particular world configuration of four millennia ago. Within the cosmic harmony there is an infinite capacity, as Pande says, for self-expression; changing circumstances call forth changing configurations. It is the broad features, and the purpose of Rta that we must intuitively apprehend, and then seek to articulate.

We also need to recognise that if the cosmic order is stressed, it will react to set the balance right. The Vedic poet '…said that *Rta*, though benign, can be "stern and fierce" in respect of transgressions. Brihaspati rides the fearsome chariot of *Rta* for destroying the wicked (Chaitanya, 2000, paraphrasing Rigveda 2:23:3).' Half a century and more of nature-stressing agricultural and industrial 'development' is throwing up signals that, if rightly understood, can guide us in restoring balance to our land, forests, rivers and human communities. If we ignore these signals, and think that the problems of development can be solved by more development, our world will change irreversibly for the worse; maybe it will even die. Let us not discount the Vedic concept of the four ages (*yugas*) of human society. 'One feature of the Kali epoch, when man's nature will sink to the nadir of grossness, will be that he will indulge in the wanton destruction of the flora of the Earth (Chaitanya, 2000, referring to a discourse of the sage Markandeya in the Mahabharata Vana Parvan, Chapter 190).'

Right living, right livelihoods

Being parts of a living universe, individual human beings, families and communities must, in the Vedic worldview, serve the needs of the cosmic

order. This implies, in the first place, a striving to understand the cosmic order. The gods are petitioned through prayers and hymns for 'light', which may be translated as the ability to cognise the patterns of *Rta* as actualised in nature (both the inner and outer world of human beings). Right action then flows from right knowledge. This is the rationale for the vast, complex body of practical guidelines for every aspect of human life.

In the practical conduct of everyday life, two themes predominate: sacrifice (*yajna*) and restraint (*tapas*). Regarding sacrifice, the Encyclopedia Britannica (1992, article on Vedism) says:

> Vedism was almost entirely concerned with the cult of fire sacrifice (*yajna*) and the continual regeneration of the universe that resulted from it. By means of the correspondences that linked the ritual to both the macrocosmos and the microcosmos, the sacrificer simultaneously contributed to the welfare of the transcendental order and furthered his own interests.

The necessity of sacrifice to maintain the cosmic order has already been mentioned. This passage further makes the point that human welfare can be secured only by seeking the welfare of the larger contexts in which the sacrificer is embedded (family, local community, local ecosystem and the entire physical and middle realms).

The second theme is of *tapas*. This Sanskrit word conveys a composite meaning. Literally it means 'heat'; its derivative meanings are 'inner energy', spiritual 'fervour' or 'ardour', 'asceticism', 'penance' (Panikkar, 1977). In Rigveda verse 10:129:3 we are told that world creation is the result of *tapas* (rendered as 'ardour' in the following translation by Panikkar [2001]).

> Darkness was there, all wrapped around by darkness, and all was water indiscriminate. Then, that which was hidden by the void, that One, emerging, stirring, through the power of ardour, came to be.

The sense here seems to be of the unlimited, indefinable One, delimiting or defining itself by an effort of will.

Not only the initial creation, but also the continued maintenance of the cosmos requires *tapas* on the part of created beings, including human beings. In practical, everyday terms, this means that a person's activity must be confined

within the limits defined by an authentic representation of *Rta* in order to maintain the cosmic balance. It further means that when the balance has been upset for any reason, effort, in the form of austerities and an intense mental and emotional concentration to create a high charge of psychic energy, must be made to induce the gods to restore the balance.

The myth of Ganga depicts, along with many other themes, the need for *tapas* to ensure world maintenance. Ganga is the water in the *kamandala* (a water pot carried by a *sadhu*) of Brahma (the creator of the universe) that purifies the world. Through human inadvertence the ocean dried up causing a cessation of rainfall and the flow of rivers. The pious king Bhagirathi undertook severe *tapas* on behalf of mankind and, as a result, obtained a boon from Brahma. He requested Brahma to let Ganga descend to earth. Thus was the life-giving water cycle restored. (Recounted, in brief, from Vatsyayan, 1992)

Prayer, as a petitioning of the gods to order events so as to ensure human welfare is also a conspicuous part of Vedic life. In Krishi-Parashara, a practical manual of farming (Sadhale, 1999), prayer is prescribed in preference to any direct physical measures to influence the course of natural events.

Modern men and women, of course, cannot see how prayer can be effective, and if it clearly is effective in specific instances he or she says it is the manifestation of the 'supernatural'. In other words, it cannot be explained with the concepts his materialist worldview supplies. What he or she must appreciate is that in the Vedic worldview no event whatsoever is outside the cosmic order. The petitioner, the god whom he petitions and the ability of the god to influence the course of events, in the physical, emotional or mental spheres, are all possible within, and are regulated by, *Rta*. As we said earlier, the gods, no less than men, are constrained by *Rta*. Of course, the effectiveness of prayer depends upon the purity of the petitioner. Parashara in verses 130 -131 (Sadhale, 1999) refers to the need to bathe and to put on fresh, white clothes before offering prayers at the commencement of ploughing. These acts are, of course, symbolic of moral cleansing. Verse 8 of Krishi Parashar refers to the need to expiate sin caused by the unintentional harm done to living beings in farming.

Science in Vedic culture

What is scientific knowledge? How is it obtained? How is it used, and to what effect? These are questions that every culture has answered, each from the standpoint of its own particular worldview. The purpose of this section is to explain and contrast modern science and the Vedic science.

Scientific knowledge results from the observation of phenomena, both the inner phenomena of sensations, emotions and thoughts, and the outer world of physical objects and events. These observations are then represented by the observer to himself or herself in terms that accord with his or her *a priori* suppositions about what is real, as specified by his or her worldview. The representations thus formulated, if they are to be shared, must be given form as language (spoken and written), mathematical equations, or physical artefacts. Underlying the entire enterprise is the conviction that there are regularities in the workings of nature that can be discovered by observation. Once discovered, it is possible to make predictions about the future in regard to these naturally-occurring processes and so accommodate ourselves to, or to manipulate, them in an attempt to secure human welfare. Knowledge is effective in proportion to the care that is taken in observation, and the adequacy of the concepts constituting the observer's worldview.

The knowledge of any particular type of phenomenon has two distinct elements, descriptive and explanatory, law and theory (Box 5.2 *Some essential definitions*). In the case of the solar system, for example, the descriptive element is a bare statement, a mathematical equation or set of equations, or a physical model such as Ptolemy's or Kepler's. A separate statement or set of statements explains why the observed regularities in the given phenomenon are thought to occur. Before the Enlightenment in the West and almost universally in Non-Western cultures, even to the present, the behaviour of the solar system was and is explained by saying that it is an organism. Newton invented the concept of force as an explanation. In his theory of universal gravitation he combined law and theory in one statement.[7]

As a background to a description of Vedic scientific practice it will be useful to describe the modern scientific method in its essential features.

Scientific methodology in contemporary global culture

Given the materialist worldview, the knowledge of modern science is concerned with discrete individual physical entities and the relationships between two, or at the most only a few, of them at any one time. The classical way of obtaining knowledge in this paradigm is exemplified by Galileo's laboratory experiments on balls rolling down inclined planes, or by such experiments as we all did in school physics like deriving the relationship between pendulum length and the period of its swing.

In such experiments as these, an attempt is made to create 'ideal conditions', an abstraction in which everything that can affect the behaviour of the balls or pendulum are held in abeyance. An effort is made to eliminate the effects of sloping laboratory benches, air currents, inadequate light, the occurrence of earthquakes, friction, and so on The results can then be precisely expressed in mathematical terms.

The elaborate design of these experiments attests to the scientist's belief that the physical relationships so discovered describe the true nature of phenomena. The everyday experience of seemingly infinite complexity is simply a nuisance, a cover to be cleared away or penetrated by the clever scientist to reveal the truth.

The 'true nature' of phenomena can, in his or her view, be reduced ultimately to material particles in motion, acted upon by forces. This reductive approach means formulating what were termed micro-explanations in Chapter 5.

Applied to biological phenomena, this approach requires much more strenuous effort and more ingenuity to approximate 'ideal conditions'. Thus in agricultural research we not only have 'state-of-the-art' laboratories, but also glasshouses, research stations and, since all these still cannot adequately create ideal conditions, we have devised statistical methods to estimate the probability that our experimental results truly represent the simple, physical causation that we are convinced is the real, ultimate explanation of a biological phenomenon. Further, the 20th century physicist, to his dismay, also found that even the laws of mechanics could no longer be expressed with mathematical certainty, but only in terms of probability. This has not, however, yet affected mainstream science, nor, in

most scientists' minds, brought into question the basic tenets of their inherited 19th-century worldview.

The technology based upon modern scientific knowledge is indeed powerful, but produces unexpected 'side effects'. The 'side effects', amounting to widespread environmental, social and economic breakdown, are clear signals that the real world is, in fact, complex and not the simple affair pictured to us in school science textbooks. The entire structure of modern scientific knowledge is thus being threatened by developments within the science laboratory and outside in nature and society. And the most strenuous efforts of scientists over more than half a century have failed to counter this threat. It is clearly impossible for them to do so unless they change their basic assumptions as to the nature of causality.

Scientific methodology in Vedic culture

In Vedic times an attempt was made to understand a given phenomenon in terms of its place in a larger context, rather than in terms of the interactions among its constituent elements. In other words, a macro-explanation was sought. The ultimate, all-embracing context is the entire universe. Every event is 'caused' by every other event in the universe that ever has, or ever will, occur. Every event occurs as it does because the universe is as it is. Everything is inter-related, bound into a seamless spatial-temporal whole – by *Rta*. Attempting to isolate any particular pair of events to study it as an isolated interaction is, from this point of view, meaningless.

If one can characterise the state of the universe at a given time, and note how various events of immediate concern unfold subsequently, one can develop a system of predictive knowledge. Vedic people used the relative positions of the planets as convenient 'marker' events to characterise the state of the universe at a given time. Omens, that is, unusual events of a more proximate nature, were also used as 'markers'.

If observation is carefully done and a record, mental or otherwise is maintained, and a systematic process of induction is followed, an effective body of scientific knowledge can be built up. We can only suppose that observational techniques

that led to the rainfall predicting formulae described in Krishi-Parashara and later farming manuals were of a high order.

The Vedic worldview, as we have seen, postulates a correspondence between the micro-cosmos of the individual person and the macro-cosmos or outer world. Events in one were seen to be correlated, in symbolic terms, to events in the other. This appears to be the rationale for such a proscription, for example, on storing seed in the house of a barren woman (Krishi-Parashara, verse 161) (Sadhale, 1999). Whether the observational base for this proscription and many similar ones was adequate we do not know; a practical farming manual does not describe experimental details, and presumably there was nothing equivalent then to our familiar research reports.

The objective of the application of this knowledge was to enable people to adapt to natural phenomena, and not, as with modern technology, to manipulate and control them. Much of our technology today is violent, causing the disruption of natural systems ('unexpected side effects'). This would have been seen as a sacrilege by Vedic people, since for them all nature is sacred. They also realised that to fail to adapt to the cosmic order would invite disaster, something we today are beginning to perceive.

Vedic people also sought their welfare by prayer – that is, by petitioning the gods. They realised that the gods can influence, within limits, the course of events, and that they do respond to the requests of human beings. The attitude and behaviour of the supplicant, however, is important in determining the effectiveness of prayer. It is important to remember that the gods do not transgress *Rta* in fulfilling requests; they too are subject to *Rta*.

When people pray for a beneficial turn of events, they are being manipulative and not simply adaptive. But the nature of the manipulation is different from that which we practice. It seeks to modify the course of events from, as it were, a cosmic level, rather than at a local level. The proof of this is that the effects of prayers, when answered, do not lead to a negative impact in any other direction. Our manipulative technology is clearly against the 'law', judging by the negative 'side effects' of so much of it. We have lost all intuitive sense of the cosmic harmony or cosmic law.

Information feedback

Experimentation is essential for building a useful body of knowledge whatever the overall scientific paradigm. We have discussed experimentation in the modern materialist science paradigm, but a further word needs to be said about it in the context of Vedic science. I wish to suggest that Vedic science is, in essence, what we would term today, ecological science or the science of living systems. Experimentation in this scientific paradigm can be seen as a dialogue; in the words of E. F. Schumacher:

> …The whole of human life is a dialogue between man and his environment. We pose questions to the universe by what we do, and the universe, by its response, informs us whether our actions harmonise with its laws or violate them.
>
> (Paraphrased by Chaitanya, 2000)

Systems response gives us information, or feedback, that we can use to refine our question (plan of experiment) if necessary and pose it again. In this way we can hope to fine tune the technique that we initially formulated on the basis of theory derived from the general concepts of our worldview. It is important to recall that the feedback will be immediate and proximate (local systems) as well as delayed and distant (or generalised) (larger, enclosing systems). The latter are particularly difficult to observe, but in the long run are the more important. From a systems viewpoint, the use of insecticides in agriculture, for example, may seem to have an immediate beneficial effect at the local (field) level, but a deleterious effect in later years and on a village and regional scale.

Masanobu Fukuoka has given us, in describing the development of his method of natural farming, a specific example of a research as a dialogue (Fukuoka, 1994). The similarity to the Vedic mode of experimentation sketched above will be obvious. The rationale for his science paradigm is Buddhist metaphysics, and not Vedic, and his climate, soils, and cultural context also differ, but all these are incidental for anyone wishing to understand his method.

It appears to me that answers to the 'questions' our ancestors posed became evident only centuries later, and even then were difficult to perceive and understand. This may explain why efforts have not been made, until recently, to correct the trends of village forest destruction and soil erosion from cultivated

land. Equally, this neglect of feedback information may be due to human selfishness and greed that predisposes all of us to value only the immediate and proximate, ignoring the ethical standards of society derived from the society's worldview. Such ethical standards seek to regulate human behaviour in accordance with the universal intuition that individual welfare can only be secured in the context of the welfare of the whole of society.

Technology transfer

We are now in a position to attempt to answer the question: can knowledge be transferred across cultures? Say, from Vedic times to the present? This question is complex; the answer is not simple.

In general, the answer is 'no'. The knowledge of every culture is a product of its specific worldview, and since the Vedic and modern worldviews are so different, Vedic knowledge is useless to us. Prayer and formal sacrifice would not work for us as crop production practices unless we and everyone else in society shared the worldview that gave rise to them. This is not possible in the present-day world, even in India where remnants of the Vedic worldview are still a part of most people's emotional and intellectual orientation to life.

Many features of the Vedic way of life resonate deeply within us today. And not only within us in India, but also for people in other parts of the world as well. In Chapter 8 I suggest that this is because we have come to a stage in human history when the intuitions that found expression in Vedic times are coming to the surface again today. How we formulate them to serve our needs is a challenge of *de novo* construction; we cannot copy the ancients.

Having said this, we need to consider astrological prediction as a special case. That it works today in the area of rainfall prediction has been demonstrated (Kanani, 2007). It could well replace our present-day techniques based upon more proximate observations with no loss of accuracy – and probably with considerably less expense. It is a technique that can be, and, indeed, is used directly by farmers as Nene (1999 a) has pointed out. However, it would be the 'odd man out' in the present-day scientific establishment. On the other hand, it would find a congenial home in a worldview such as I have sketched in Chapter 5. A rider must, however, be added. If climate change occurs,

and, indeed, there is much evidence now that it is occurring, it might well be that the precise formulations of the ancients for predicting rainfall and crop yields will no longer work. New correlations could be worked out, but to do so would probably only be worthwhile if climate is not continuously changing, which does not appear likely for perhaps the next couple of centuries.

Notes

1. We are no longer able, at least in our public and professional integrations, to read the language of concrete symbol, just as we are unable to read the symbols of dreams, so important to ancient people of all cultures. The remarkable feature of the dream symbols of contemporary people who participate in the worldview of contemporary global culture is their similarity with the symbols of ancient myth. These symbols are indeed universal, common to all human beings irrespective of time and culture, as has been shown by C. G. Jung with his discovery of what he terms 'archetypes of the collective unconscious' (Jung, 1956).

2. There is also a five-fold division of the human being as explained at Taittiriya Upanishad 3:2-6 (Hume, 1931). These divisions are the *annamayakosa*, the *pranamayakosa*, the *manomayakosa*, the *vijnanamayakosa*, and the *anandamayakosa*. The first corresponds to the physical body, the second, third and fourth together correspond to the subtle body, and the fifth is the same as the causal body (Sharma, 1937).

3. It seems to me that the thinkers of the European enlightenment (see Chapter 6) went fundamentally wrong when they assumed that human beings could achieve freedom from nature by the exercise of reason – that human beings were not her servant, but could become her master. The Vedic seers used reason only to make explicit their deep intuitions of the workings of nature and fashioned a civilisation that recognises that freedom can only be achieved by self transcendence. Indian society is defined in great detail, with the individual's duties and permitted pleasures spelled out. And yet, anyone wishing to step out of the established social order exclusively to follow the spiritual path as a homeless wanderer can do so. Society supports such individuals, meeting their minimum needs, but the individuals are not bound by the social order. Sri Madhava Ashish (1976) has argued convincingly that the *sadhu* is essential to society's health because it is from the ranks of *sadhus*

that many of our greatest saints and sages have emerged. In modern times when this arrangement seems to be breaking down, the greatest spiritual teachers, from Sri Ramakrishna onwards, have taught us how spiritual attainment, freedom, can be achieved in the midst of ordinary worldly life. This is a remarkable demonstration of the vitality of Indian civilisation, of its ability to change with the times without compromising its basic values and aims.

4. As living beings, or living systems, the planets possess the power of self-movement, knowledge and intelligence. Each knows its place in the larger solar system of which it is a part and it moves as necessary in order to remain in that place and thus perform its unique function in the solar system. The modern scientist may consider it 'primitive' to ascribe life, and hence the power of movement, to the planets, and yet he or she avoids altogether trying to explain the cause of their motion. Newton's first law of motion says only that physical bodies in motion (such as planets) continue so uniformly and indefinitely unless acted upon by external 'forces'. But why they should continue to move so he does not say. We might also note that his concept of 'force' is no less speculative than that of 'life' assumed by the people of ancient cultures.

5. 'The most important Vedic myth is related to creation. It is the myth of Indra destroying Vrtra and releasing the cows and the streams of water that had been stolen by the latter. Vrtra is the power of chaos and darkness, of sterility as opposed to creativity. The cows and streams of water are beams of light, symbolising the forces of life and creation (Pande, 1990, pp. 212-13)'.

6. See, for example: Atharveda 12:1 (Earth) (Panikkar, 2001); Krishi-Parashar verses 130 and 131 (planets) (Sadhale, 1999); Atharveda 6:142 (Panikkar, 2001) and Ahuja et al. (2001) (plants); Rigveda 10:9 (water) (Griffith, 1896); Rigveda 10:94 (stones) (Griffith, 1896). Parashara says that farming is a sacred activity (verse 8, Sadhale, 1999). In fact all human activities are seen as sacraments.

7. The 20th century logical positivists insist that the scientific enterprise is entirely and exclusively descriptive; that is, no attempt whatsoever should be made by scientists to explain phenomenal. In practice they do not adhere to this because they assume the laws of mechanics which have a built-in explanatory element – force.

Interpreting India's Agricultural History

Historical interpretation is a notoriously subjective undertaking. Any account of history tells us as much about the historian as about the past of which he or she writes. A. N. Whitehead, in his book *Adventures of Ideas*, wrote:

> Gibbon's history demonstrates a two-fold tale. It tells of the Decline and Fall of the Roman Empire through a thousand years… But throughout this history, it is Gibbon who speaks. He was an incarnation of the dominant spirit of his own times. In this way his volumes also tell another tale. They are a record of the mentality of the eighteenth century.
>
> (Whitehead, 1933, p. 13)

Today, we can see this same phenomena in our own work, but it is more complicated because we are passing through a major transition phase of world history, a time when the certainties of even 25 years ago are giving way to doubt and new formulations of the nature of reality are beginning to appear. Thus we sometimes look at the past from one, and sometimes from another, point of view, often unconsciously. The force of habit, of cultural conditioning, including education, cause us to view the past in the generally accepted way, that is, in terms of

what may be called the 'progress' theory deriving from the materialistic worldview of present-day mainstream global culture, while at times the force of contemporary reality causes us to abandon our habitual way of thinking and to attempt to evaluate the past in terms of entirely new, and as yet, quite tentative, theories.

Among those of us interested in agricultural history there is, in fact, agreement that the 'generally accepted way' is no longer tenable. But unless we carefully define what that way is, we are unaware how pervasive it is and how it unconsciously affects our thinking and our judgments. As for the new theories, we must work at articulating them more clearly so that their usefulness as explanations of historical fact can be assessed. This is part of the larger challenge of articulating a new and more adequate contemporary worldview of which our theory of history will be a part.

This last point needs emphasising. We are not pursuing historical research as an ivory-tower, academic pursuit. We desperately need a clear vision of an alternative future to the one that appears to be taking shape at present. We are looking to the past for guidance. Above all, we are looking for ideas on the basis of which we might construct an alternative worldview. Our particular theory of history, however, may preclude our recognising such ideas. It seems to be true that we can only **see** what we expect to see. For example, if we employ the progress theory we become so preoccupied with facts (that is, practices, techniques) that we entirely fail to see the concepts that gave rise to them, the very concepts that might be useful today.

Looking through back issues of Asian Agri-History and the commentaries on the historical documents published by the Asian Agri-History Foundation, I find that altogether four different theories of history are implied by the various interpretations offered. I have invented a name for each. Each theory is evaluated in terms of its comprehensiveness, or how completely it takes into account all known facts, and to what extent it helps us to understand ancient agricultural systems and their relevance to us today in our quest for sustainable agriculture.

The progress theory

Randhawa (1980, Chapter 19) and Nene and Sadhale (1997) have examined selected verses of the Rigveda for their references to agricultural practices.

This approach yields information about the crops that were grown in Vedic times and the practices followed. Virtually all these are still to be found today in traditional agriculture in various parts of the country.

With this approach to the study of agricultural history there is a tendency to evaluate ancient practices and techniques in terms of whether or not they are intelligible from the limited standpoint of simple physical causation posited by modern science.[1] Thus some practices 'make good sense', display 'an excellent understanding', and 'can be justified on the basis of the knowledge we possess today', while others are considered 'incomprehensible', 'difficult to accept', or simply 'superstitions' (Nene, 1996, 1999 a and b). Documents with a greater proportion of practices of the latter type accordingly have 'an inferior knowledge base' (Nene, 1999 b).

If we arrange the major texts in a chronological order, beginning with the Rigveda verses referred to above, we see a distinct time trend. In the Rigveda verses (written down about 3700 BC) we see what might be termed the Vedic mode of human interaction with nature in the form of prayer, sacrifice, austerity and purity to ensure human welfare. Krishi-Parishar (Sadhale, 1999) (earlier than 400 BC) by and large depicts the same mode: an example is the token harvest ritual. Over the centuries this Vedic mode slowly gave way to more specific, direct, physical methods of interaction such as the use of plant extracts rather than prayers to control crop pests and diseases. This trend can be seen by comparing the Rigveda verses and Krishi-Parashar with Kautilya's Artha-Sastra (400 BC) (Nene, 1999 a), Varahamihira's Brihat Samhita (500 AD) (Bhatt, 1981), Surapala's Vrikshayurveda (11th century AD) (Sadhale, 1996) and Dara Shikoh's 18th century Nuskha Dar Fanni-Falahat (Akbar, 2000). To complete this list we may add a recent example of an agricultural manual, the Indian Council of Agricultural Research's *Handbook of Agriculture* (ICAR, 1980). In this we find the transition to a knowledge based upon the modern scientific paradigm completed. This gradual transition from the Vedic to the modern scientific orientation is seen as 'progress' from 'primitive' beginnings with a very limited 'knowledge base' to the 'advanced' technology of contemporary scientific agriculture (Nene, 1999 b; Chandra, 2000). Or, as Virmani writes, 'I am not suggesting for a moment that the people of Surapala's

time had already achieved a level of agricultural technology equal to what we know in modern times (Virmani, 1996).'

Finally, we may note the suggestion of many commentators that ancient practices, at least those that are not 'superstitions', need to be validated experimentally, using modern experimental methods. (Jeyarajan, 2000; Mehra, 1996; Nene, 1999 b; and Peter, 2001).

All these ways of looking at history derive from what might be termed the progress theory. This theory is based upon the assumption that there is an evolutionary trend in world history, a steady, inevitable accumulation of knowledge, approaching a 'true' understanding of nature. Present-day, mainstream global culture, including modern science, is seen as the furthest development of this evolutionary process, while all previous cultures are seen as stages leading up to it. Such terms as 'primitive' used for our ancestors' knowledge, and 'progress' applied to the difference between their practices and ours, indicates that the historian is employing the progress theory.

The progress theory is a part of the worldview of present-day global culture. It comes naturally to present-day scientists who have been socialised and educated in that culture. Nevertheless, we must question it.

In the first place, it is usual to view all textual statements as simple matters of fact. Many statements, however, are symbolic, such as, in the following two verses:

> "O Indra! You removed the barriers that impeded the flow of the seven rivers." (Rigveda, verse 1:32:12)
>
> "O! Vajra-holding Indra! You opened the door of the cave of Balasura who had stolen cows: the Devas, who had been harassed by Balasura, surrounded you shedding their fear." (Rigveda, verse 1:11:5)
>
> (Translation: Nene and Sadhale, 1997)

These verses are interpreted by Nene and Sadhale as evidence for dams on the seven rivers, cutting off supplies of water for irrigation and domestic use, and as evidence of cow stealing. The latter, we can well imagine, is probably a matter of fact, but the former seems highly improbable. The point in both cases, however, is that the symbolic meaning has not been sought.

The symbolic meanings described in Chapter 7 may be more important for us than the facts, even if correct, for providing insights into the Vedic worldview.

Another example is Rigveda verse 1:50:6:

> O Sun! You are the purifier and protector of everything. We praise the light by which you look after this world and feed all living beings. (Translation Nene and Sadhale, 1997).

This is interpreted by Nene and Sadhale (1997) as meaning that Vedic people recognised the role of the sun in the growth of plants and hence in the production of food. This they probably did, but is there not also another, symbolic meaning?

Evaluating ancient practices in terms of whether or not they can be explained by modern scientific theory is also a questionable procedure. In Chapter 7, I have briefly described the Vedic worldview, and attempted to show that it is a discrete, coherent, logically consistent and effective way of relating to the world. In terms of this worldview, statements that are incomprehensible to us can be seen to make very good sense.

Further, if ancient Indian agricultural practices derive from a distinct, self-sufficient worldview, and agriculture of that era is seen as reasonably successful, and certainly as more successful than our own, then on what basis do we call it 'primitive', or in what sense has there been 'progress'?

Third, we need to question the logic of the suggestion that ancient knowledge should be validated experimentally, using modern experimental methods. The assumption underlying this suggestion seems to be that we can achieve sustainable agriculture in the future by a mere tinkering with modern agriculture, adding a few ancient practices (if they are validated) and dropping a few that are most obviously destructive,[2] but leaving the basic framework intact. In my opinion, this will not suffice; the science that has given rise to modern agriculture is flawed and needs to be replaced. If this science is flawed, then setting it up as a standard against which to evaluate ancient practices appears meaningless.

In this connection we must also recognise the possibility that we may not be able to validate specific practices, at least from the Vedic period, by modern

experimental methods, since the underlying theories of causation in the Vedic and modern scientific paradigms are entirely different (see Chapter 7).

Finally, we need to enquire into the origin of this progress theory. That is, we must examine it against the totality of mankind's experience on this planet – in so far as we have records of it – with a view to testing its claim to universal validity. This is the subject of Chapter 6, from which it should be clear that the concept of evolution or progress on which this theory is based is not a feature of Indian traditional culture. It is strictly a European notion forced upon us by European colonialism, and now voluntarily accepted by us in the form of 'development' and 'globalisation'.

In conclusion, the progress theory appears to be of limited usefulness because it primarily confirms us in our own knowledge rather than helping us to understand the knowledge of our ancestors. It delegitimises traditional knowledge.

The rediscovery theory

In the past two decades or so an ecological critique of modern modes of human interaction with nature is rapidly taking shape and giving rise to demands for new, sustainable ways of living and of interacting with nature. Many similarities are evident between ancient practices and these new approaches. One way of attempting to explain this similarity is what might be termed the 'rediscovery' theory. According to this theory our ancestors possessed modern concepts and effectively operationalised them in their own setting. Consider the following three statements.

1. 'Our ancestors in ancient times realised this problem much before the advent of modern science and developed unique ways to conserve plant biodiversity.' (Ahuja *et al.*, [2001] writing about the problem of species extinction due to present-day human interference in nature)
2. 'It seems that the text was written to help conserve plant biodiversity…' (Mehra [1996] commenting on Surapala's Vrikshayurveda)
3. '…Surapala's tome suggests that many theories of our times were first

> logically thought out or hypothesised by the ancient thinkers of India some 1000 years ago. (Virmani [1996] commenting on Surapala's Vrikshayurveda)

According to the authors of the first two quotations, the present-day concept of biodiversity conservation existed in ancient India. Virmani suggests that many present-day concepts were originally formulated in ancient times. Thus, far from being 'primitive' or at an early stage of evolutionary development, our ancestors are seen as having possessed concepts that were subsequently lost. They have been rediscovered in recent times. The rediscovery theory thus rejects the mainstream progress theory. This is all to the good, but we must question critically whether or not this specific formulation is justified in view of what we know of Indian religious and cultural history. I have argued that the reverence the ancients felt for plants, and indeed, all living beings, and the protection they afforded them, were expressions of a conviction that all life is sacred (Jackson, 2002 a). This conviction derives from the worldview of the times (see Chapter 7). Some similarity may be seen between the Vedic and the modern ecological concepts, but their formulations are different and the practices that flow from them are also different.

The relativist theory

The relativist theory also rejects the mainstream progress thesis. It asserts that ancient cultures exhibit coherent, logical systems of ideas and practice, though derived from different premises than those of modern global culture. These premises and systems are neither preludes to contemporary forms, nor do they need to be validated by them. As Virmani (1996) remarks: 'A study of Vrikshayurveda leads one to believe that there is no reason to suggest that any particular innate racial or national deficiency exists in any region of the world to develop systems of knowledge.' The Vedic worldview, for example, is a self-sufficient and effective means of organising life.

In the course of presenting a critique of modern science (Chapter 5), I have suggested the essence of this theory in the following words:

> The foregoing excursion into the history of metaphysical thought highlights the tentative, speculative nature of [our present-day] atomic, materialist worldview.

> This perception should lead us to see that no system of thought, or worldview, is 'true'. All systems are only tentative, fallible structures we put together to help us make sense of and cope with the world. There have been other structures in the past, some still existent and not by any means untrue or useless, and there will be others in the future, such as the new, holistic, ecological worldview that currently appears to be taking shape. The comings and goings of these structures depends ultimately on their success in practice.

Balkundi (1998 and 1999) and Nene (1999 a) have commented extensively on the prediction of rainfall in ancient India using astrological methods. From the general tenor of these comments, it seems to me that they both write from the standpoint of the relativist theory; that is, they accept astrology as a valid science in its own right. They have nowhere in their comments on the astrological prediction of rainfall used the language of the progress theory.

In my opinion, the relativist theory explains existent facts more satisfactorily than the first two theories. Nevertheless, as it stands, this theory does not allow us to connect meaningfully with our past since the worldviews of different cultures, or of different eras within cultures, are seen as mutually exclusive structures. The key scientific ideas of any culture derive from the worldview of that culture. Astrology, for example, derives from the Vedic worldview.[3] The present-day university agriculture curriculum is based upon the modern scientific worldview which is incompatible with the Vedic worldview. The introduction of a course on astrology into the agriculture curriculum, as suggested by Nene (1999 a), would create a fundamental incoherence in the curriculum that would undoubtedly create confusion and uncertainty in students' minds.[4]

Further, the relativist theory cannot explain the remarkable correspondences between Vedic agriculture and the present-day concepts that form the post-modern, ecological, or systems science paradigm, which is the main concern of the rediscovery theory.

The theory of universal intuitions

After rejecting the progress theory, we have been working our way towards a comprehensive alternative. The following two requirements for such an alternative have been identified.

1. It must recognise the worldview of whatever culture or era is being studied as a valid system of ideas in its own right, and requires us to understand the agricultural techniques of that culture in terms of that worldview.

2. If possible, it should explain the remarkable similarities between the techniques of farming, and modes of interacting with nature in general, in the past era being studied and the analogous practices deriving from the ecological or systems worldview of the present time.

Elsewhere I have suggested that the essential feature of an alternative theory that meets these two requirements could be the idea that the intuitions that have given rise to ancient concepts and present-day ecological concepts are the same (Jackson, 2002 a). People all over the world are today spontaneously, and seemingly independently, experiencing the intuitions of the livingness, the unity and the inter-relatedness of all that exists.[5] These same intuitions seem to be the foundations of ancient, as well as contemporary tribal, worldviews as well,[6] giving rise to the conviction that they are indeed universal in time and space. Four of the key intuitions thus encountered are listed in Table 8.1, along with an indication of the conceptual formulations they have taken in an ancient culture and in the ecological or systems worldview.

It should be noted in passing that while the theory of universal intuitions flows from the post-modern worldview, it has at the same time helped to define that view. Looking at the past from an ecological point of view has enabled us to recognise ancient concepts as giving expression to intuitions we too have, and to which we are struggling to give expression in our current context. Such recognition is difficult, or impossible, if we are working with the progress theory.

The same thing can be said about the progress theory. It gains its validity from the worldview of contemporary global culture, and at the same time justifies it. The theory is only valid as long as there is a consensus among those concerned. With the decay of that worldview, the progress theory is no longer valid. The theory of universal intuitions will be valid only if there is a consensus among us on an ecological or systems worldview such as I have suggested in Chapter 6.

Table 8.1. Four key universal intuitions and the concepts they give rise to in the Vedic worldview and in the alternative worldview suggested in Chapter 5

Intuition	Concepts	
	Vedic worldview[a]	Alternative worldview[b]
A universe emerging from and supported by an unmanifest, indescribable unitary principle.	*Brahman*, the unmanifest source and support of the universe. A complex universe of many realms, each ruled by a deity.	A unitary source and ground of subject and object. These interact to produce experience.
The universe and all its constituent parts are living beings.	Gods, men, demons, animals, plants and even 'dead' matter are living beings, parts or manifestations of the One Life, *Brahman*. All are sacred and elicit devotion and protection.	The universe is a system, consisting of a hierarchy of systems. A system is a cyclical, self-sustaining process. Systems are self-created and self-maintaining living entities.
The universe as a whole, and each of its parts are governed by a single, all-embracing order.	*Rta*, or cosmic causal agency, determines and regulates all that exists.	Natural law as immanent in things and activities.
A person's duty in life is to strive to understand the universal order, and in all his or her activities, to maintain it.	Rules of conduct, deriving from an attempt to understand the requirements of *Rta*, specifying the duties of human beings to each other, to community and to the natural world.	Human communities are seen as systems embedded in natural ecosystems. Constraints are to be observed by individuals and communities to ensure continued health of systems/ ecosystems.

(a) See Chapter 7 for details.

(b) See Chapter 5 for details.

In using the theory of universal intuitions as a research tool, we do not evaluate or judge ancient concepts and practices from the standpoint of whether or not they conform to our own, but how effective they are in ensuring the sustainability of the system of which they are component processes. The difference is subtle but vital. In my comment *Religion and Biodiversity* (Jackson, 2002 a) I wrote that our ancestors did not need our concept of biodiversity. The implication is that their concept of the sacredness of all nature is as valid and as effective as our concept of biodiversity. This was written from the point of view of the relativist theory. I continue to maintain that we should refrain from directly comparing concepts across cultures or cultural eras, of judging one in terms of another. The further development of the idea of universal intuitions, introduced in the same paper, can serve as a basis for a trans-cultural point of view from which to evaluate, more or less objectively, the concepts and practices of any culture. All cultures of 'The Way' (that is, those that are based upon the intuitions we are discussing – see Table 8.1 and Note 6) recognise the need for human beings to interact with each other and with the rest of nature in ways that attempt to honour the constraints imposed by the need to maintain healthy systems. In other words, they recognise the need for sustainability.

An example of the application of this approach is provided by the evaluation of *jhum* cultivation (Chapter 3). The first step was to set up sustainability criteria. Albert Howard's concept of 'Nature's farming' was chosen for this purpose (Howard, 1940). He elaborated this concept by stating that natural forests are stable over long periods of time; therefore, if we want to farm sustainably we must design practices that imitate natural processes as exhibited by undisturbed forest in the area where we farm. This appears to be an authentic expression of the intuition of the all-embracing natural order, and of the duty of human beings to maintain it. He then derived from his concept four general guidelines for the development of practical farming techniques. I used these as sustainability criteria[7] to evaluate *jhum* cultivation.

The results of this exercise were that *jhum* cultivation is, if undisturbed by external human influences (such as the market economy), more or less sustainable. At some places levels of soil erosion were judged to be too high for the system to be completely sustainable. This is in contrast to their other practices, such

as those that maintain the biodiversity of their system. In terms of the theory of universal intuitions, the reason higher than acceptable levels of soil erosion might be seen as a failure of *jhum* cultivators to design a method of sowing that adequately reflected their overall concern with sustainability. We will return to this subject in a moment for a more detailed consideration.

Using the same criteria, Indian traditional sedentary farming was judged still less sustainable because of its failure to adequately conserve village forest and prevent soil loss. One reason for this might be practices (forest burning and grazing, ploughing and clean weeding) that do not adequately give practical expression to the basic concepts of Vedic culture (Table 8.1).[8] Take, for example, the practice of ploughing. The challenge facing any community beginning farming in a virgin ecosystem is to replace the natural vegetation, entirely or in part, by introducing selected plant species to produce food and other necessities. The study of ancient farming systems reveals that there are several ways in which this has been done. The simplest approach, the one adopted by Vedic farmers, is to clear the land of native vegetation and keep it clear by ploughing and mechanical weeding. This bares the soil surface for most of the year, leading to its deterioration (that is, loss of soil organic matter and of the soil itself through erosion). Vedic farmers worshiped Sita (Rigveda verse 4:57:6). Nene and Sadhale (1977) equate Sita with 'ploughed field'. Panikkar (2001), however, says that Sita represents the furrow[9]. The difference is important. If Sita means furrow, farmers' attention was focused on the limited process of growing a crop, and not on the well being of the field[10]. Making furrows amounts to ploughing and thus baring the soil surface.

A similar explanation could perhaps be advanced for the gradual deterioration of village forest. The practices of worshipping particular species of plants, and even of maintaining sacred groves, as an expression of the concept that living things are sacred, apparently did not prevent people from behaving indifferently towards forests in their generality.

A second possible explanation for the less than complete sustainability of Vedic agriculture might be a failure to 'see' and understand symptoms of systems stress, as we would say from the point of view of the alternative science paradigm suggested in Chapter 7. In my experience this is a problem

even in present-day traditional farming in India (see Box 8.1 *The Kurmula grub*). It has a parallel in present-day Western (and Westernised) urban people who feel passionately for nature and wildlife – for biodiversity – and seek to preserve it in wildlife sanctuaries, and at the same time are oblivious to the destruction of biodiversity in agricultural ecosystems.

In discussing the progress theory earlier, we noted a gradual shift from macro- to micro-explanation technologies from Vedic times to the present [11]. Upto the 19th century or so there was no conceptual shift, but only a slow erosion of the exclusive reliance on technology based upon macro-explanations. If farming ecosystems gradually deteriorated, and this was not understood, farmers may have attempted to compensate for an increasing ecological destabilisation of farming ecosystems and the resulting decline in production by introducing violent micro-explanation technology (for example, the use of plant extracts as insecticides, the burning of crop stubbles). These practices, of course, do not restore lost balance; indeed they increase it, as recent experience with chemical pesticides has shown. The frequency and intensity of such practices must continuously be increased to maintain yields, thus aggravating the basic problem – loss of ecosystem balance or health.

Third, an obvious, explanation, is that Vedic people, like everyone else, seldom, or ever, completely lived up to their own highest conception of right behaviour. The 'demons' of selfishness, greed and lust (including the lust for power or control over nature – or even the desire for tidiness) often got the better of them – and the natural order suffered. The urban environmentalist referred to in a previous paragraph may fail to see the destruction of biodiversity in agricultural land because to do so would be bad for business.

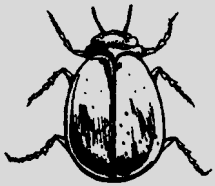
The theory of universal intuitions thus makes possible a new understanding of Indian agricultural history, and a new valuation of its significance for our future. To summarise:

1. Vedic agriculture is a logical, coherent and effective system, but it can be understood only in terms of the Vedic worldview.

2. The Vedic worldview comprises concepts that are, in essence, common to most, perhaps all, ancient worldviews and to contemporary tribal

Box 8.1

The *kurmula* grub

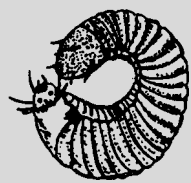


In Uttarakhand white grubs (*Anomala dimidata* and *Mimela fulgidivittata* are the most common) is a major pest of crops. They are polyphagous, feeding on the roots of upland paddy, *mandua* (*Eleusine coracana*), *madira* (*Echinochloa frumentacea*), *bhat* (black soyabean) and most vegetables. The adult beetles feed on the flowers of maize and *bhat*, French bean, fruit trees like plum, apricot and peach, and ornamentals like dahlia. Both grubs and beetles also feed on a variety of broadleaved forest trees and shrubs. Garg (1992) has described the biology of this insect and suggested control measures which include light traps for beetles (they feed mostly at night), chemical pesticides applied to the soil to kill grubs, and picking grubs out of compost (compost piles are a favourite place for egg-laying).

I had been hearing from farmers for many years that the problem of *kurmula* grubs has become more severe within living memory, and also that putting pine needles in the compost pile (after using them for bedding for animals) was somehow responsible for this. At the same time, most older people in villages also say that in their youth oak and other broad-leaved species still grew in their village support area, and the leaves of these species were the main bedding material, but now only pine is present.

This information, and the fact that pine is an indicator of support-area and general village ecosystem degradation in this area (Chapter 1), led me some years ago to formulate the hypothesis that the problem of *kurmula* is a case of displacement of a species within an ecosystem that is degrading. According to this hypothesis the natural food of this insect is broad-leaved forest trees and shrubs, both roots and leaves. With the disappearance of these as support-area degrades, the insect shifts to crops, and, with the disappearance of deep, natural forest soils rich in plant roots and decaying organic matter, to laying its eggs in compost piles. Concurrently, perhaps, natural predators became fewer, and *kurmula* became a 'pest'.

If this hypothesis is correct, we have here a symptom of ecosystem stress (that is, a feedback signal) that is not being recognised as such by rural people. Or at least they are not able to conceptualise the problem in a way that would lead them to seek a macro-explanation solution, that is, rehabilitation of their village support areas. Neither is it seen in this way by agricultural scientists. Both, therefore, see *kurmula* as a 'pest' to be killed – a micro-explanation solution. In desperation some farmers are now spraying the insecticides recommended by scientists.



worldviews. These concepts give expression to universal human intuitions of the 'Way' of the universe – the way of maintaining universal systems health (see Note 6).

3. The alternative worldview suggested in Chapter 5 shares these essential concepts, expressed in terms appropriate to our present world context. In fact, the ecological farming paradigm ('Nature's farming') can be seen as a continuation of the Vedic agricultural system, even though it is described in a contemporary idiom.

4. In studying Vedic agriculture we are therefore interested in the system as a whole, not merely with selected techniques. That system is the village ecosystem described in Chapters 1 and 5.

5. The experimental method of Vedic agriculture may be termed a 'dialogue with nature' (see Chapter 7). In agricultural research in the systems paradigm, we look for what is termed systems feedback information.

6. If Vedic agriculture has not been entirely sustainable, the reason may be a failure to recognise and understand the systems feedback signals that have been thrown up over the centuries. We are better placed today because we have the benefit of hindsight. We have an opportunity to devise appropriate course corrections (Figure 8.1). It is also possible that some of the practices of Vedic agriculture did not adequately reflect the general concern of Vedic culture with sustainability, that is, with the necessity to embody in practice the constraints imposed by the need for ecosystems health. Undoubtedly, the 'demons' of selfishness and greed also dimmed Vedic people's perception of the need for 'right action' – as they dim our vision today, in spite of our best intentions.

7. If the theory of universal intuitions informs our thinking our attention will focus more on the *de novo* formulation of concepts that are authentic expressions of our own deepest intuitions in our own context, and the invention of corresponding practices, than on seeking to copy practices from the past. The transfer of techniques across cultures is generally not even possible since they derive their rationale and effectiveness from differing worldviews (see Chapter 7).

Figure 8.1. Vedic agriculture was not completely sustainable. The slow deterioration of village support area is an important symptom of this. We are in a position to repair the damage done. Here school children are engaged in a practical exercise of village support-area rehabilitation, They are building walls (with guidance from village residents) and constructing a gully plug (with class teacher overseeing). They are also measuring their enclosed plot in order to calculate its area, and then tree sapling requirement. Further, they are measuring soil depth to assess the site for its suitability for various species of trees. (Source: UEEC, 2008)

In conclusion we can say that Vedic agriculture is a continuing experiment. We are called upon today to take charge of it. Looking at it through the eyes of the theory of universal intuition we see that the basic experimental design is sound. As for details, it must be elaborated/ modified in ways that meet the specific challenges we now perceive.

Notes

1. For a discussion of causation, see Chapter 6.

2. A brochure announcing a National Conference of India's Agricultural Heritage for February 2001 expresses this point of view. 'This is the right time to rediscover our past heritage of sustainable agriculture and blend it with the modern agriculture, simultaneously discarding harmful practices that were adopted during the past several decades.'

3. Some mainstream scientists deny that astrology is a science, arguing on the basis of observational procedures and rules, and the theory of causation employed in modern science (Narlikar, 2001). If science is defined narrowly in these terms, reasons can be found to disqualify ancient procedures and knowledge as science. As Parthasarathy and Robinson (2001) have commented: 'Both the content and utility of science, in their (that is, mainstream, modern scientists) arguments, are sacrificed at the altar of method and procedure.' This is another example of interpreting history in terms of the progress theory. For a discussion of causation in ancient and modern science, see Chapter 7.

4. The introduction into the curriculum of a course on astrology, could, however, be an opportunity for students and teachers to seriously discuss the basic premises underlying Vedic and modern science, the science of other ancient cultures and contemporary tribal cultures, and also ecological science. This would be all to the good. Such classroom discussion is now recommended for schools (UEEC, 2001) and universities (Jackson, 2003 b).

5. James Lovelock, the scientist who formulated the Gaia hypothesis, has written: 'When I first saw Gaia in my mind I felt as an astronaut must have done as he stood on the moon, gazing back at our home, the Earth. The feeling strengthens as theory and evidence come in to confirm the thought that Earth may be a living organism. Thinking of the Earth as alive makes it seem, on happy days, in the right places, as if the whole planet were celebrating a sacred ceremony.' Quoted by Sachs (1999, p. 123).

6. For a sample of the current research into Vedic and contemporary Indian tribal societies see Chaitanya (2000) and Sen (1992). An example of contemporary tribal societies is the *jhum* cultivating tribes of tropical highland Asia (Chapter 3). The Ecologist special issue *The Cosmic Convent*, volume 30 (1), 2000, describes the findings of investigations into ancient Islamic, Christian, Jewish, Greek, Egyptian, Zoroastrian and Chinese cultures, and also into contemporary tribal societies the world over. Concluding his survey of many cultures, Goldsmith refers to the common foundation of all as 'The Way' (Goldsmith, 2000 a).

7. To these four, I added three more that can also be seen as deriving from Howard's basic concept, and also from formal ecological theory.

8. There is considerable evidence in the Rigveda itself for forest destruction – burning and grazing (Nene and Sadhale, 1997). This is in addition to contemporary evidence (Chapter 1). We may, I think, in view of the contemporary evidence for unsustainable levels of soil erosion, assume that excessive soil erosion also occurred in Vedic times.

9. 'Auspicious Furrow (Sita), we venerate you. We pray you, come near us to prosper and bless and bring us abundant harvests'. Rigveda verse 4:57: 6 (Translation: Panikkar, 2001).

10. The opening verse of Rigveda 4:57 is addressed to Ksetrapati (literally Lord of the field), but Panikkar considers that he is 'God of the ploughshare and of happiness'. If this is so, it again indicates a preoccupation with the process of growing crops (Panikkar, 2001).

11. For a fuller discussion of this distinction see Chapters 5 and 7. A macro-explanation describes the plant in terms of its place and function in the ecosystem of which it is a part, that is, the field, the village, the region and the Earth. An example of micro-explanation technologies is the use of pesticides. Organic, or natural pesticides, and modern synthetic chemical pesticides are not different in essence. They are both based upon a micro-explanation of nature, and both cause ecosystem destabilisation. The former are probably more dependable, and certainly have fewer deleterious side effects, than the latter, but generically they are the same. It is, however, important to document the micro-explanation technologies of the past. In our effort to restore the health of agricultural ecosystems, the use of plant extracts as pesticides in place of synthetic chemical ones, for example, will ease the transition towards truly natural systems of farming.

12. A decisive change came only in the 19th and 20th centuries as a result of colonialism and development (Chapter 6). Even the Muslim invasion and subjection of most of India between the 14th and 18th centuries did not bring any marked change in farming theory or practice. (Many useful plants and their cultivation techniques were, however, introduced.) This is suggested by comparing farming manuals from earlier times with Dara Shikoh's 18th century Nuskha Dar Fanni-Falahat (Akbar, 2000).

9

Whither Agricultural Education and Research?

In the earlier chapters of this book I have attempted to sketch a vision of an alternative future for rural India – an alternative to the modernisation and globalisation that are now unfolding, and which are generally accepted as being inevitable. I have argued that the real challenge before us is to bring about a fundamental change in our outlook, or worldview, as I have called it. Anything less than this will not lead to truly sustainable agriculture, food security, or healthy rural communities in the future. Both the content of contemporary agricultural education and the institutional framework we have built to deliver it reflect the mindset which has created this problem of unsustainability. By the same reasoning, the subjects of our agricultural research and the institutional framework within which we pursue this research cannot lead to a solution of our problem; they are part of the problem.

In this chapter I wish to suggest ways in which Indian agricultural education and research would need to be reoriented to bring them in line with the alternative vision that I have outlined. The logic of this vision appears to demand a radical decentralisation of both these activities so that rural people themselves again become the primary educators and researchers. In doing this I will begin by reviewing agricultural research and education in the Vedic

period, the colonial and post-independence period, and also examine the methods being developed in conjunction with the natural farming movement.

Educational and research methodologies in the Vedic period

Research

Vedic agricultural research methodologies can be learned from ancient texts as well as from traditional farming communities – provided we have the key, which is an understanding of the Vedic worldview. The main concepts we need to grasp are that the context of Vedic agriculture is nothing less than the entire universe, that causation is multiple and circular and not simple and linear, that everything in nature, from the smallest to the largest, including everything we consider inanimate, is living, and that the universe consists of many realms, not just the physical. Vedic research methodologies flow from these concepts. In general, research consists of posing a question and waiting for a systems answer (that is, a systems feedback response).

These methodologies were not, however, made explicit, as far as I can ascertain. We have the classical Vedic texts and farming manuals such as *Krishi-Parashar* which systematise existing knowledge, but they do not describe research methodology. In those days there were no textbooks and scientific journals as far as we know. We can, however, infer Vedic techniques from the scientific paradigm of the times. Such inference indicates a whole-farm, or whole-village experimental context, and evaluation criteria that measure general ecosystem health. (I employ present-day ecological concepts and terminology here, but do not want to imply that Vedic people thought in these terms). Immediate benefits to crop production and animal and human health are legitimate only in so far as they do not disturb ecosystem health and stability.

The farmer is himself or herself the researcher. He or she makes changes in his or her existing farming system, such as, say, an alteration in sowing date, or a variation of a traditional harvest ceremony, or the species proportions in traditional mixed crops, and then observes the feedback in terms of total systems behaviour. If the feedback is positive, the new practice is adopted by others and thus becomes a regular feature of the farming system thenceforth.

An analogous procedure would presumably be followed at the level of the village ecosystem with the community as a whole taking decisions. In devising experimental treatments to be tested, the farmer or community would presumably be guided by past observation of where and how the existing system exhibited less than optimal performance; they would use a process of deductive reasoning, beginning from a theory of how *Rta*, the cosmic causal agency, manifests in their specific setting.

Research in Vedic times was thus an integral part of everyday farming. The modern research station, of which we are so proud today, would have been incomprehensible to the Vedic farmer, and would probably have been seen by him or her as a very dangerous way to do agricultural research.

Education

Education in Vedic times in livelihood pursuits like farming, trades and crafts, including priest craft, was presumably acquired by young people by an informal apprenticeship process, mainly within the family. Discussion among farmers, within the village and at local fairs, was probably an informal mode of transferring livelihood knowledge – as it is today. The exchange of seeds implies an exchange of information as well.

The concept of livelihood training outside the home/ farm/ business in schools and universities was apparently absent in Vedic times. The aim of village schools that came into existence in post-Vedic times was to impart literacy, numeracy and a knowledge of spiritual and literary works. In the later Vedic period, Taksashila, in the far Northwest, if not a university in the modern sense, was comparable to the university cities of medieval Europe (Basham, 1991). Nalanda, in Bihar, founded in the Gupta period, was essentially a monastery. Both centres, in addition to religious studies taught philosophy, logic, grammar, medicine, and probably mathematics, music and astrology. Livelihood subjects like agriculture seem to have been absent.

The pedagogy employed in traditional village schools was one of rote learning, which was appropriate to the content of the curriculum. The ability to read and write were simply aids to preserving and propagating ancient texts unaltered in terms of content and mode of recitation. The same was true

of Muslim schools, only the texts that formed the curriculum were Persian (Kumar, 1991).

Village schools were not numerous in most parts of the country in the pre-colonial period, and even where they were, school enrolment was restricted to only a few children.

The colonial and post-independence periods

The historical review of education and research presented in the previous section provides the essential background for our enquiry 'whither agricultural education and research'? To complete this background survey we must also look at the history of school education in general, agricultural education at the university level and agricultural research in the 19th and 20th centuries.

The objectives of colonial education policy were to provide education for the 'moral upliftment' of Indians, which meant, in reality, changing their worldview to that of their masters to render them more tractable, and to impart skills that were useful to the colonial administration such as geography, (western) science and agriculture. The colonial education system catered to only a small fraction of the total population and created a new elite class, alienated to a great extent from their cultural roots. Traditional schools and apprenticeship modes of learning continued for the majority.

The administration of school education and the training of teachers in the new system was done by the colonial government administration. Teachers' salaries were paid by government, whereas traditionally they were paid by the community, usually in kind. Teachers in the traditional system were residents of the villages where they taught. In the colonial system, teachers were posted according to administrative convenience, usually not in their home villages.

Thus the teacher's links with the village were thus largely broken in two ways. They were no longer directly supported by the community and so were not responsible to it. They usually were outsiders with no roots or stake in the village community. Also, they taught subjects which were irrelevant to village life.

Even the children's link with the community was broken; the home and the school became two mutually-exclusive areas of life. Modern school education also devalued farm work and traditional knowledge.

The state management of school education required a uniform syllabus and a system of inspection to ensure that teaching conformed to the syllabus. The objective of education being to provide trained manpower to run the administration, uniform, comprehensive examinations were required. This led to the continuance of the traditional Indian mode of learning in which the memorisation of texts and their correct recitation was the aim. Today, even after a half century of independence, this mode of learning continues, and is an impediment to the type of education we now see as necessary since it does not lead to the development of critical thinking ability.

According to Krishna Kumar there is another reason why the traditional mode of rote learning persisted in the colonial educational system.

It is a reasonable hypothesis that the memorising of texts, apart from being a familiar skill for the Indian child, is also an instinctive defence against a body and form of knowledge that looked hostile to everything that was meaningful to the child's environment. Such a hypothesis would be tenable from a psychological point of view. Children learn by rote what they cannot understand, or do not want to understand for an emotional reason. Children everywhere protect themselves in classrooms with the help of memorised reproduction when they are faced with concepts or material that they cannot grasp or find meaningless (Kumar, 1991, p. 63).

There can be little doubt that the knowledge imparted in our school education even today is foreign (literally, as it is Western) and is unrelated to the child's real world. Children study only in the hope that it will get them a good job; or, more accurately, because their parents hope it will get them a good job.

The result of this colonial education policy was that traditional education, which was an inbuilt feature of traditional community life, atrophied. Children turned their backs on traditional culture and livelihood training. With the intensification of 'modernisation', on a Western model, after independence, this trend has accelerated.[1] Today, if they learn about agriculture at all it is

modern agriculture taught at school – an agriculture that they cannot, in many contexts, practise, or that brings ecological devastation and economic ruin if they do.

A strong current of thinking among school educationists is now emerging that recognises the need for rural reconstruction, with a vital role for school education in achieving it. It is, however, a role that school education can play only if it is drastically revised. It must be related to children's cultural background, address local livelihood needs, emphasise investigative, group project work and a discussion mode of teaching, and provide for the questioning of both tradition and modernism (UEEC, 2001).

The school course *Our Land, Our Life* (UEEC, 2008) has been found to have a liberating effect on both students and teachers. It is the only course in the curriculum, they say, that relates to their real world. Learning becomes meaningful and enjoyable. It has been marked that some poor students, judged by conventional examinations, suddenly display remarkable interest and achievement in this course (Kishen Singh Suyal, UEEC staff member and former intermediate college principal – private communication).

High on the colonial agenda was the production of export crops, especially wheat, sugarcane, cotton, jute, and various plantation crops.[2] This was achieved by selectively increasing the areas of their cultivation through administrative coercion and by increasing yields. For the latter purpose training in agriculture was begun at the university level, and agricultural research institutes were set up. Lord Curzon (Viceroy, 1898-1905) in a speech to the Bombay Chamber of Commerce asked the question 'What have we been doing for agriculture?', and replied, 'Our real reform has been to endeavour for the first time to apply science on a large scale to the study and practice of Indian agriculture (Randhawa, 1983, p. 270).' The British had no doubts that their own brand of agricultural science was the paradigm on which both these enterprises were to be modelled. No one in a position of authority in India since then has for a moment doubted the wisdom of Curzon's initiative.

Provincial Departments of Agriculture had been set up in 1881. Their main work was collection of statistics and famine relief. From 1905 they were expanded and given a fresh mandate: agricultural research, demonstration

and education. Experimental farms and agricultural colleges were set up or reorganised. In addition to catering for research, experimental farms were also to be depots for seeds, fertilisers and implements.

With the coming of independence, the narrow colonial focus on export crops initially widened to include all the important traditional crops. Later, in the late 1960s it again narrowed to wheat, sugarcane, cotton and rice which could produce surpluses to feed our rapidly increasing urban population and industries (Bajaj, 1999). Indian scientists had all along resisted the western chemical-physical model of crop production as we could not altogether abandon our traditional organic model, but, in the late 1960s this resistance was completely broken and we enthusiastically embraced the green revolution 'package of practices' philosophy (Chapter 4). Our present agricultural university system and our extensive network of agricultural research institutes are designed to foster green revolution agriculture, or, as the newer concept would have it, 'global agriculture'. We need to consider how they might be modified to meet the newly perceived imperatives of natural farming.

Lessons from the natural farming movement

The similarities between the speculative reconstruction of Vedic agricultural research methodology suggested in the last section and the methodology being employed by present-day natural farmers are obvious. This is not surprising in view of the fact that the scientific theories underlying Vedic and natural farming are, in essence, the same. In Chapter 8, I suggested that the Vedic agricultural experiment is a continuing reality; continuing traditional forms of farming present us with a remnant of Vedic farming, albeit degraded, and natural farming might be considered a new incarnation of it, featuring vital course corrections.

The experience of the now numerous farmers across the country who have opted out of the 'system' and are pursuing more natural, sustainable farming confirms this conclusion. Their experience can also suggest specific ways in which this reorientation may be done. We will therefore now look into this body of contemporary farmers' experience.

In the first four decades of the 20th century Albert Howard, working in India, pioneered what he termed 'Nature's farming' (Howard, 1940). In the last three decades of the 20th century Masanobu Fukuoka in Japan developed an even more radically new system which he termed 'natural farming, or 'do nothing farming' since he was able to eliminate much of the hard work of both modern and traditional farming practice (Fukuoka, 1994, p. 15-18). Both men, in addition to being brilliant scientists, had an intensely practical flair and demonstrated beyond doubt the soundness of the concepts on which their systems were built (Boxes 9.1, *I resolved to break new ground*, and 9.2, *Do nothing farming*). Fukuoka, in addition, provides informal apprenticeship training to young people who come to his farm, stay a while, work with him and learn.

They both began with the conviction that natural processes, if not unduly interfered with, can give us productive and sustainable agriculture. The key phrase here is 'not unduly interfered with'. They insist that we must desist from attempting to control natural processes. Instead we must learn to see them collectively as a system. This system does the farming by itself; our role is gently to orient it to the production, to the extent possible, of the types of biomass we require for our sustenance. This requires a detailed knowledge of natural systems, the very existence of which modern materialist science fails to recognise.

Natural farming research

Howard and Fukuoka gained their knowledge by observing the reaction of a discrete farming system, as a system, to their various innovations. Howard managed, against great odds, to create his 'farms' – one at Pusa in Bihar and the other at Indore in Madhya Pradesh – where he had a free hand for his research (Box 9.3, *A farm of his own*). Fukuoka took over his ancestral farm and began his experimentation, resulting in acute embarrassment to his old father, since the neighbours thought the son mad. One of Fukuoka's early experiments on citrus trees, he readily confesses, was a complete disaster; he killed more than 400 trees (Fukuoka, 1994, pp.13-14, 16).

During the past three decades farmers in every corner of India have pioneered new systems of natural farming.[3] Most of them had practised modern chemical

Box 9.1

'I resolved to break new ground'

'More than fifty years have passed since the modern work on the diseases of plants first began. What has been the general result of all this study of vegetable pathology? Has it provided anything of permanent value to agriculture?... Why is there so much of this disease? Can the growing tale of the pests of Western agriculture be accounted for by some subtle change in practice? Can the cultivators of the East, for example, teach us anything about diseases and their control?

I resolved to break new ground... and to observe what happened when insect and fungus diseases were left alone and allowed to develop unchecked, and where indirect methods only, such as improved cultivation and more efficient varieties, were employed to prevent attacks. This point of view derived considerable impetus from a preliminary study of Indian agriculture.

In order to give my crops every chance of being attacked by parasites, nothing was done in the way of prevention; no insecticides and fungicides were used; no diseased material was ever destroyed. As my understanding of Indian agriculture progressed, and as my practice improved, a marked diminution of disease occurred. At the end of five years' tuition under my new professors - the peasants and the pests - the attacks of insects and fungi on all crops, whose root systems were suitable to the local soil conditions, became negligible. By 1910 I had learnt how to grow healthy crops, practically free from disease, without the slightest help from mycologists, entomologists, bacteriologists, agricultural chemists, statisticians, clearing-houses of information, artificial manures, spraying machines, insecticides, fungicides, germicides, and all the other expensive paraphernalia of the modern Experiment Station.'

(Howard, 1940, pp. 162-5)

agriculture and become disillusioned. Many were the 'progressive' farmers of the green revolution era. Cezar Gomes of Guirdolim village in Goa in an interview with Claude Alvares (Alvares, 1999, pp 193-4) recalls that:

> From 1952 to 1976 I used chemicals and my yield did go up fantastically. So much so that I was awarded a gold medal...for the highest paddy yield in Goa (10,000 kg per hectare) in 1952. However, as years went by, I learnt to my dismay that synthetic fertilisers were ruining my soil and plants, infesting them with plenty of unknown diseases.
>
> (Alvares, 1999, p. 193-4)

Many retired professional people have bought land, or have returned to their ancestral land, to try natural farming. Some young people have opted out of the urban rat race and taken to natural farming as an alternative way of life, like Vivek and Juli Cariappa in Hasalar village in Karnataka (Box 9.4, *The 'second chance' farm*). Despite the varied background experience of these people, they basically share the philosophy articulated by Howard and Fukuoka of accommodation to natural processes. They speak of 'studying nature', of 'bio-balance' (that is, the maintenance of a balanced ecosystem) as a strategy for disease and pest management in crops, and of weeds and termites as 'friends'. In general they do not speak in terms of traditional concepts, which is understandable since their earlier commitment to modernisation has severed them from their traditional roots. An interesting example of this is D. D. Bharamagoudra in Yellavati village in Karnataka (Box 9.5, *My real teachers were my son and daughter*). A spiritual dimension is not, however, altogether lacking, though it may be expressed in a more culturally-neutral idiom (Box 9.6, *Soil is divine*).

All these pioneers are fiercely self-reliant, and they need to be since public institutions have so far generally not supported them. Their neighbours are uncomprehending. Many natural farmers report being ridiculed initially. After years of struggle and having achieved a measure of success, they have, however, won grudging acceptance (Aggarwal, 1994). Neighbours begin to come to their farms to have a serious look and the pioneers often find themselves with an increasing responsibility to share their experience with others (for example, Box 9.4).

The research methodology of all these contemporary natural farming pioneers, whether they begin with traditional farms, farms that have been ruined by modern agricultural methods, or barren land, follows that of Fukuoka and Howard: watch how the farming ecosystem heals itself when the stresses of traditional practices, like the grazing of domestic animals, or of modern agriculture, like the application of synthetic chemicals, are removed, and then carefully and gently observe how the entire system (that is, the farm ecosystem) reacts to their interventions. The interventions (that is, experimental treatments)) are planned on the basis of what the farmer understands of the structure and

Box 9.2

Do nothing farming

'For thirty years I lived only in my farming and had little contact with people outside my own community. During those years I was heading in a straight line towards a "do nothing" agricultural method.

The usual way to go about developing a method is to ask "How about trying this?' or "How about trying that?" bringing in a variety of techniques one upon the other. This is modern agriculture and it only results in making the farmer busier.

My way was opposite. I was aiming at a pleasant, natural way of farming which results in making the work easier instead of harder. "How about not doing this? How about not doing that?" – that was my way of thinking. I ultimately reached the conclusion that there was no need to plough, no need to apply fertiliser, no need to make compost, no need to use insecticides. When you get right down to it, there are few agricultural practices that are really necessary. The reason that man's improved techniques seem to be necessary is that the natural balance has been so badly upset beforehand by those same techniques that the land has become dependent on them.

In applying my theories to farming, I have been experimenting in growing my crops in various ways, always with the idea of developing a method close to nature. Take a look at these fields of rye and barley. This ripening grain will yield about 22 bushels (1,300 pounds) per quarter acre. I believe this matches the top yields in Ehime Prefecture... And yet these fields have not been ploughed for twenty-five years.

To plant, I simply broadcast rye and barley seed on separate fields in the autumn, while the rice is still standing. A few weeks later I harvest the rice and spread the rice straw back over the fields. It is the same for the rice seeding. This winter grain will be cut around the 20th of May. About two weeks before the crop has fully matured, I broadcast rice seed over the rye and barley. After the winter grain has been harvested and the grains threshed, I spread the rye and barley straw over the field. You might also notice that white clover and weeds are growing in these fields. Clover seed was sown among the rice plants in early October, shortly before the rye and barley. I do not worry about sowing the weeds – they reseed themselves quite easily.

Such is the yearly cycle of rice/ winter grain cultivation by the natural method. The seeding and harvesting so closely follow the natural pattern that it could be considered a natural process rather than an agricultural technique.

In caring for a quarter-acre field, one or two people can do all the work of growing rice and winter grain in a matter of a few days.'

(Collated from Fukuoka, 1994, Chapter 1)

functioning of his or her system; they are, as I have termed them Chapter 4) techniques based upon 'macro-explanations'. If the response of the system is positive (that is, increased system health), the technique is pursued. A farming system thus evolves that is specific to the particular farm. This accounts for the myriad versions of natural farming that have been created around the country.

Because there is such a diversity of farming conditions in India it is impossible to formulate a 'package of practices' for natural farming. Partap Aggarwal pointedly refused to advise farmers. He said farmers could come to his farm and see what is done there, and then find their own way (Aggarwal, 1994). Fukuoka's book has had a great influence in India, and yet Indian farmers cannot follow his particular method. In dryland conditions, for example, his method of sowing (simply broadcasting seed on an unploughed field) seems well-neigh impossible, and yet all agree that the principle of 'no ploughing' is important. At the Sarang School (Box 9.6) seed is dibbled through the mulch, but this seems to be a lot of work. The use of straw as mulch is also a problem in a South Asian context where it is used to feed large ruminants; composting seems inevitable, and perhaps mulching has to be done with compost rather than the original straw, and again this is more work. Weed control in paddy is achieved by Fukuoka by flooding his fields for a few days; this weakens the undercrop of clover and weeds. Aggrawal (1994) in India and Evans (2000) in Nepal accomplish the same thing, when the paddy is small, by grazing cattle in the field, or by hand cutting the under-crop of clover for animal fodder. Natural farming is thus one continuous experiment on every farm, and to succeed every farmer must be a researcher. The idea that the university or institute scientist does research and the farmer applies the results is entirely foreign to natural farming.

The difference between research in the context of the prevailing agricultural science paradigm and in the context of natural farming needs to be spelled out. The two are based upon different theories of causation. The natural farming theory is what might be termed universal, simultaneous and reciprocal causation, while the modern science theory is of limited, linear causation (Chapter 7). The experimental context of natural farming research is therefore a whole farm. Thus there cannot be any 'controls' in the strict sense of modern

Box 9.3.

A farm of his own

'I took up research in agriculture as a mycologist in the West Indies in 1899, where I specialised in the diseases of sugarcane and cocoa and became interested in tropical agriculture. Almost at once I discerned a fundamental weakness in the research organisation: the mycologist had no land on which he could take his own advice about remedies before asking planters to adopt them.

My next post was botanist at Wye College in Kent, where I was in charge of the experiments on hops and had ample opportunities for studying the insect and fungous diseases of this interesting crop. But again I had no land on which I could try out certain ideas that were fermenting in my mind about the prevention of hop diseases.

In 1905 I was appointed Imperial Economic Botanist to the Government of India. At the Pusa Agricultural Research Institute, largely through the support of the Director, the late Mr. Bernard Coventry, I had for the first time all the essentials for work – interesting problems, money, freedom, and last, but not least, 75 acres of land on which I could grow crops in my own way and study their reaction to insect and fungous pests and other things. My real training in agricultural research then began...

It was possible for me to approach the subject of plant diseases in this unorthodox manner for two reasons. In the first place the Agricultural Research Institute at Pusa was little more than a name when I arrived in India in 1905. Everything was fluid; there was nothing in the nature of an organised system of research in existence. In the second place, my duties, fortunately for me, had not been clearly defined. I was a therefore able to break new ground...

By 1918 the organisation of research at Pusa had gradually become more rigid; the old latitude which existed in the early days became a memory. That essential freedom, without which no progress is possible, had been gradually destroyed by the growth of a research organisation based on fragments of science rather than one the practical problems which needed investigation. The instrument became more important than its purpose. Such organisations can only achieve their own destruction. This was the reason why I decided to leave Pusa and found a new centre where I should be free to follow the gleam unhampered and undisturbed. After a delay of six years, 1918 to 1924, the Indore Institute was founded.'

(Howard, 1940, pp.163-9)

research methodology. The only 'controls' are the ecosystems of the natural farmer's neighbours who have stuck to traditional or chemical farming (Boxes

9.6 and 9.7). Further, the assessment of experimental results (that is, systems feedback) cannot be quantified in terms of one simple variable, as, for example, the grain yield of wheat. Rather, the total yield of (all forms) of biomass must be assessed, as total biomass production has a direct bearing on ecosystem health. Other indicators of ecosystem health are such things as soil condition, spring flow rates, water table level, degree of biodiversity and stability in the face of climatic perturbations (Box 9.7, *Agro-ecosystem resistance to natural disasters – a case study*).[4] Further, assessment requires comparison with a previous state of the ecosystem, a task made more difficult because of large annual fluctuations in weather.

So far the experimental unit in the natural farming movement is the individual farm. In my view this is only the secondary context of natural farming. The primary context is the village, conceived of as a distinct ecosystem (Chapters 1 and 5). In some regions of India, like Uttarakhand, the primacy of the village is more obvious because forest (one half of village area, on an average) and water are community-owned and must be managed by the community as a whole. Further, though cultivated land is family-owned, the cropping programme is determined by the community as a whole. Thus there is one rotation for each part of the cultivated area of the village, irrespective of whose land comes in that area. Everywhere, however, the prerequisite for natural farming is a healthy village community (Chapters 3, 4 and 5).

Agricultural education

There is a great deal we can learn from the natural farming movement on the subject of agricultural education. The traditional farmer, the farmer who has ruined his land with modern farming methods, people returning to the land, or coming to the land for the first time, are all in need of education. We have dwelt so far on the self-learning by doing that is so important in natural farming. This is the source of all genuine natural farming knowledge. And yet, that knowledge needs to be shared, and passed on to our children. How is this to be done?

Before answering this question we need to note that the most important task with the adult learner is that of reorienting his outlook. Without this

Box 9.4.

The 'second chance' farm

Vivek and Juli Cariappa were young city people who wanted to live on the land. They bought a wasted, barren piece of land in Village Birwal in Karnataka and set about bringing it back to life. They named their farm 'second chance' - a second chance at life for them and for the land of which they became the 'stewards'.

Juli says: 'I cannot recount our rebirth year after year as if there was prescribed formula to share with you. That is the essence of the organic, of nature's way, and we are her children... We have learnt the need to discriminate between exploitation and partnership. We grow, we evolve through sweat, exhilaration and pain and are proud to be part of the great miracle of life.'

'Far-fetched experiments happened alongside traditional farming practices. We combined cash crops and food crops with weeds, flowers, trees and mulch and began to realise that we were doing something right. Instinctive farming does take a little longer to learn but in the end you really "know" your fields.'

'Vivek and I, seeking a way to be part of a wider awareness of the issues facing rural people today, have become active members of the Karnataka Rajya Ryotha Sangh. We are learning that farmers everywhere want to make responsible decisions for their families, their land and therefore the future of all living things. The past twenty years may have impoverished a rich organic tradition but the essence is very much alive.'

(Alvares, 1999, pp. 242-3)

initial reorientation, learning is out of the question. Only those people who have come to reject the mainstream, conventional orientation to farming are willing and able to learn. It can even be said, perhaps, that the philosophical reorientation of the learner is *the* task, since, as we have seen, there is only a limited amount of factual information that can usefully be passed on. Learners must generate that by their own research in their own farms and villages.

Neighbours begin by observing the natural farming pioneer with amusement or even pity. When he or she begins to get results these attitudes change to those of intelligent interest and active enquiry. The pioneer then finds himself/ herself in the role of teacher. Some of them then begin to venture outside their own farms/ villages to organise meetings (Box 9.4). They form groups to promote natural farming through training programmes, field visits and publications.

Sri D. D. Bharamgoudra of Yellavati village in Karnataka was an enthusiastic green revolution farmer, and he 'stopped only when yields fell and there was no remedy'. With this his re-education began; his children were his teachers (Box 9.5). This story illustrates the importance of teaching children the principles of natural farming, and hints at the potential for this in the context of the formal school system.

Children of parents who practice natural farming can, and presumably do, learn it by apprenticeship, so to speak. The most important, and indispensable component of the apprenticeship training is the alternative worldview that structures and give meaning to the lives of the members of natural farming families. What is of more concern here, however, is the vast majority of children who have no such home experience. The primary formative influences in their lives are the school system and the media both of which instil in them a modern, 'scientific', materialistic, hedonistic worldview, so that they reject rural life altogether. Only a very few young people, rural or urban, on their own come to see the modern urban middle-class lifestyle as unsatisfying and so initiate a process of self-re-education. The great majority who do not are, to my mind, the essential challenge of agricultural education today; indeed, it is the essential challenge for school education in general if our children are to achieve meaningful lives for themselves and a sustainable society.

There are two approaches to introducing natural farming into the school curriculum. One is exemplified by the Sarang School offering an alternative curriculum (Box 9.6). This is a valuable experiment, and the results can indicate the directions that curriculum reform in the general school curriculum might take. Another approach is the course *Our Land, Our Life* launched in Uttarakhand State. This course focuses on ecological or natural methods of land and water management in a village context (Box 1.2).

Where do we go from here?

The foregoing background survey of agricultural education and research in the past, and in the contemporary natural farming movement seem logically to lead to the following three guidelines for introducing change into our existing educational and research institutions and programmes.

Box 9.5.

'My real teachers were my son and daughter'

(An interview with Shri D. D. Bharamgoudra, Yellavati village, Karnataka)

Question: In your case, what are the reasons why you suddenly switched from chemical to organic farming? Is there any specific reason – or someone you met?

Reply: In our dryland area most farmers apply 10 to 20 kilos of fertiliser, mainly DAP, per acre. But I was using upto 200 kilos per acre... so that my soil would be 'healthy' (laughs). But as a result, every crop caught disease, every crop was plagued by pests. Though my neighbours' wheat and jowar did not have any pests, my crops had them. I got very good yields for seven or eight years... I stopped only when yields fell and there was no remedy. From the beginning my father had told me "Don't use chemical fertilisers and pesticides. They are no good. One day you will realise." But I was not convinced. I felt there would be many benefits, that we would become rich. It took me that long to realise that I just couldn't get rid of the pests. So I switched.

Question: But who has told you what to use in organic farming? Since all your training is in chemical farming?

Reply: The real teachers were my son and my daughter. Because even though they were not in the field they were taught in standards 1 and 2 at school. They did their farming in the backyard. They were making bunds, waterways, and so on, and were using grains and pulses available in the house... Some vegetables too. And they were using earthworms. I had forgotten what I had learnt in primary school that the earthworm is the friend of farmers.

We had so many pests in our fields... My son and daughter listened to what we were discussing in the house. My son said: "In your fields you are growing only chilli and groundnut. Here we are growing everything - jowar, wheat, groundnut, and vegetables." They did not have any pests or diseases there. It was so thickly covered there was no space to even to put a finger in there... Then my son said that they were using earthworms... I decided to use them... Then I thought of putting organic matter in the field... I started searching for information about organic farming.

(Alvares, 1999, pp. 226-8)

1. The primary laboratory, research station and classroom will have to be in the village, and be integrated with normal village life and livelihood activities. Rural people themselves will become, as they always were in the past, teachers and scientists.

2. The role of public institutions – schools, universities, research institutes and government agencies – will change. Instead of being the creators and disseminators of knowledge, they will become facilitators. Their job will be to help rural people regain the confidence and competence they have lost over the past two centuries to create the knowledge they need and pass it on to their children.

3. This change will require a profound reorientation in outlook of both public institution personnel and rural people. The essence of this reorientation will be a revaluation of traditional knowledge as well as ways of thinking and behaving, or, what amounts to the same thing, an appreciation of the natural farming perspective. Such changes will be possible only if there is a simultaneous theory shift from materialist science to what may be termed ecological or systems science.

In Figure 9.1 these three guiding principles are shown as components of a comprehensive conceptual framework that would be needed to achieve sustainable agriculture and food security in the future. More, it suggests a policy framework for sustainable rural life in general. It envisages a still broader national policy framework for a sustainable future that will be needed to favour 'localisation' in place of 'globalisation'. Localisation consists in valuing diverse cultural traditions, a focus on community, and on ecologically-sound livelihood technologies, whereas globalisation fosters a single homogenous global (that is, Western) culture, an economic system in which all power is concentrated in a few autonomous multinational corporations, and encourages governments to abdicate their responsibility to ensure social and economic security and well-being to all their citizens.

With localisation the future would evolve out of the combined efforts of all our people, and not left to be shaped, as is happening at present, by the well-off and powerful, and foreign business interests. In other words, rural people, 'backward' and tribal people – all segments of our population that have been marginalised, exploited and displaced by modernisation (as well as those at the margins of traditional society, *dalits* and women) – would henceforth participate in creating our collective future. Achieving such broad-based participation is the essence of localisation.[5]

Box 9.6.

'Soil is divine'

(Sarang School, P.O. Palakkad, Kerala)

'Sarang is basically an alternative school and has natural farming as one of its activities. The farm was established in 1982 and now covers an area of nine ha. The school is managed by seven members who all work as teachers. By 1999 thirty students were enrolled. Farming, soil and water conservation form part of the syllabus.

The founders Gopalkrishnan and Vijayalakshmi had no knowledge of alternative agriculture when they began. The land was poor because of continuous exposure to rain and ploughing year after year. They began by experimenting with mulching and not ploughing. Mulch is lifted, seeds are dibbled and the mulch is replaced. Mixed crops are grown according to household needs. They use no fertilisers or manures, and no specific pest and disease control measures are followed. The mulch controls weeds. They get double the food yield of their neighbours who plough and weed. In the upper reaches of the farm the original forest was protected, gullies were plugged, and percolation ponds constructed. Springs now flow year round.

Natural farming in Sarang is carried out because the staff are convinced that farmers and villagers should be self-reliant and free from urban domination. It also satisfies the natural diet of the community. Gopalkrishnan considers soil divine, a belief that inspired and now sustains the school.'

(Alvares, 1999, pp. 255-7)

The future of agricultural education

In this context, education can be viewed as a process that leads to enabling people to take the initiative in bringing about change. Rural people – both adults and children – need education in this sense, because they have internalised the values of the dominant, exploitative minority and thus accept their present disempowered state. Their highest aspiration is, as individuals, to join the prevailing system – which means an urban job, however subordinate it is in the system. The possibility of changing the system to allow more personal and local autonomy and responsibility does not occur to them. We are not here talking about mass protest movements, though these may at times be necessary as a tactical measure, but of enabling people to do something concrete about

their own immediate lives, in the context of their local communities. The natural farming movement and rural women's groups are examples of what is possible. However, only a few exceptional individuals have the capacity to mount initiatives of this type on their own. For the majority education, or re-education, is essential. It is not a matter of passing on information, or teaching new skills, but primarily of helping them to free themselves from a disabling worldview. This is one aspect of an educational process that I have termed transformative learning for a new worldview, or 'learning to think differently' (Jackson, 2008).

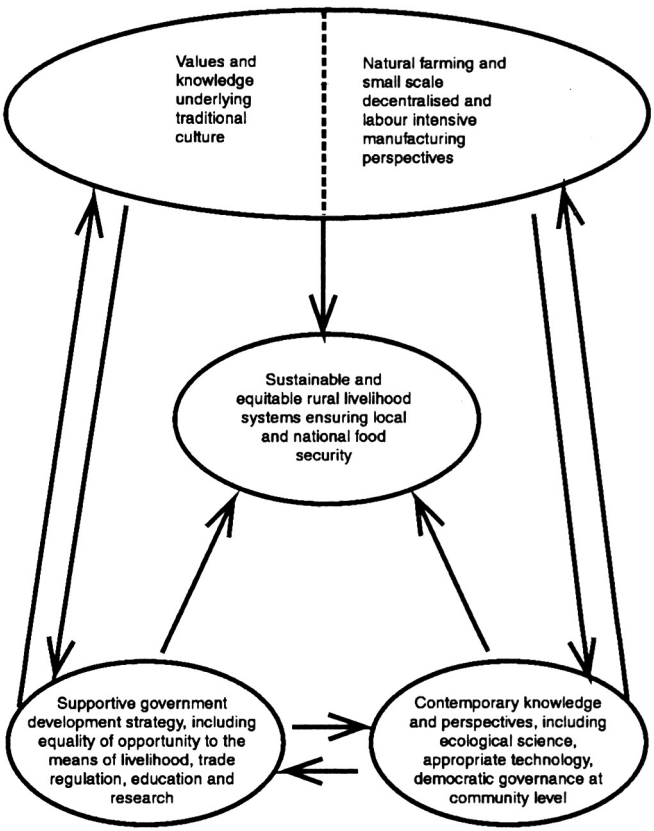

Values and knowledge underlying traditional culture
Natural farming and small scale decentralised and labour intensive manufacturing perspectives
Sustainable and equitable rural livelihood systems ensuring local and national food security
Supportive government development strategy, including equality of opportunity to the means of livelihood, trade regulation, education and research
Contemporary knowledge and perspectives, including ecological science, appropriate technology, democratic governance at community level

Figure 9.1. A broad, comprehensive, conceptual framework is a pre-requisite for co-ordinated action aimed at achieving sustainable agriculture and food security in the future. (Adapted from Shumba, 2001)

A number of people in the natural farming movement have opted out of the exploitative minority into which they were born and socialised, as we have seen. Many are providing indispensable leadership in this vast re-education project that is now getting underway. They have done this, in part, because they have seen the dark side of global culture, and have struggled to formulate alternative worldviews. They have used the knowledge and skills they learned as members of the elite community. They are serving as catalysts and resource persons. But they are too few in number. Many others of their background, in my experience, are dissatisfied and confused, and therefore need explicit help to question the status quo and explore alternative worldviews. Such questioning and exploring need to be made regular features of mainstream education, both at the school level (Kumar, 1996; Jackson 2002 c), and at the university (Jackson, 2003 b).

How are we to approach the task of changing mainstream education? A model to which we might aspire would be one in which school education is integrated with the local community; the total educational process embraces children, teachers and community (see Figure 9.2). The UEEC course mentioned earlier is designed on this model. It is appropriate to subjects in the curriculum that related directly to the local community and livelihoods concerns. Science needs to be recast in the mode of ecological science (Chapter 5).

The first and most difficult task in bringing about such change in our formal educational systems is to help teachers to see the need and possibilities for this alternative model of education. The in-service school teacher-training course developed for this purpose by the UEEC is worth considering in this regard (UEEC, 2002 a).

What role can be envisaged for agricultural education at the university level? Today we train students in modern farming technology and, increasingly, graduates aspire to jobs with agro-business firms. If, instead, we are to equip them to participate in the task of rural reconstruction outlined in previous sections, we will have to expose them to alternative development paradigms, to ecological and traditional science. They would need to spend less time in the classroom and laboratory and more time in informal project work. All students of agriculture, from both rural and urban backgrounds, will need to

Box 9.7.

Agro-ecosystem resistance to natural disasters – a case study

In October 1998 hurricane Mitch devastated Central America. "Two metres of rain in less than one week coupled with mudslides and landslides washed away crops, animals, buildings, roads and bridges. Topsoil, lost from hillside farms, silted rivers that overflowed their banks flooding fields and urban areas. Over 10,000 people died and three million were displaced or left homeless... The countries hardest hit were Honduras, Nicaragua and Guatemala.

Amidst the massive damage, detailed on-site observations revealed that farms on which sustainable practices were followed suffered less damage than their conventional neighbours. The sustainable practices generally followed were soil and water conservation measures, reduced or discontinued use of chemical inputs, crop diversification, cover crops, agro-forestry and in-row tillage.

A regional sustainable farming movement, with support from several international funding agencies, carried out an extensive and detailed three-nation study. Paired observations (sustainable versus conventional) were made on farms as near as possible to each other in the same position and cardinal orientation in the catchment, similar slope and general surroundings. Indicators of stability were: topsoil depth, rill and gully erosion, percent vegetation, crop losses and structural damage. The resulting data was analysed statistically. Sustainable farms had 20-40 percent more topsoil, greater soil moisture, fewer and smaller gullies and areas of erosion, and suffered lower economic losses than their conventional neighbours.

The results were widely discussed in meetings of farmers and with scientists and government and aid-agency administrators. As a result more than 90 percent of the conventional farmers in the study decided to switch to the sustainable farming methods of their neighbours. And many more conventional farmers who had heard of the study results also switched. The study results were favourably received by the Government of Honduras, while in Guatemala hurricane Mitch seems to have been forgotten only one year later. The Government of Nicaragua is focusing on large-scale infrastructure projects designed to support tourism and export crops rather than sustainable farming. Overall, NGO networks have failed to influence national policy, even when armed with the study results.

Lack of a favourable policy context, and the lack of political will on the part of national governments to create one, appears to be holding back grassroots efforts to extend sustainable agriculture.

(Source: Holt-Gimenez, 2001)

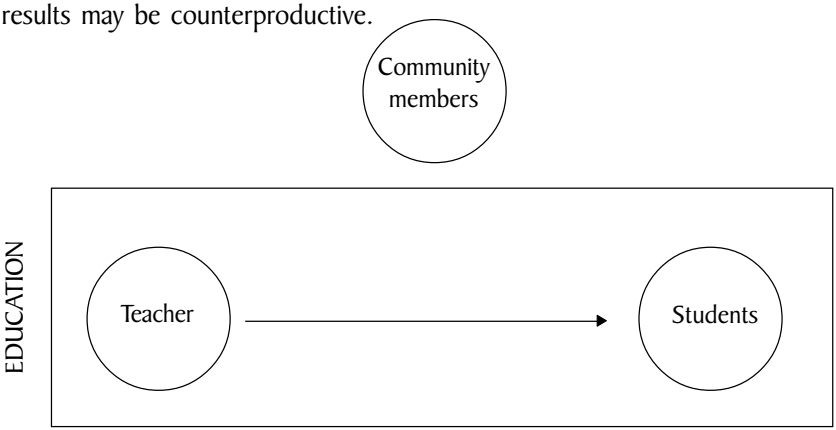
spend time learning in a village setting. Investigative project work in villages means that village communities would have to be involved in our academic programmes. At present students undergo 'practical crop production' courses on the university farm: these courses will now need to be conducted in a village setting. In fact the model suggested for school education (Figure 9.2) could serve also for university level education.

The way to begin to reorient agricultural education at the university level, as at the school level, would be, I suggest, to encourage manifold, small initiatives: experimental seminars, courses, programmes, administrative restructuring and in-training teacher reorientation workshops. As experience builds up, we may come to see the directions in which major changes can be made. The Department of Education of the Human Resources Development, Government of India is already encouraging and supporting proposals for innovations in school education of this sort from NGOs, and this type of support could be expanded. The Indian Council of Agricultural Research could similarly support individuals and groups of teachers in universities.

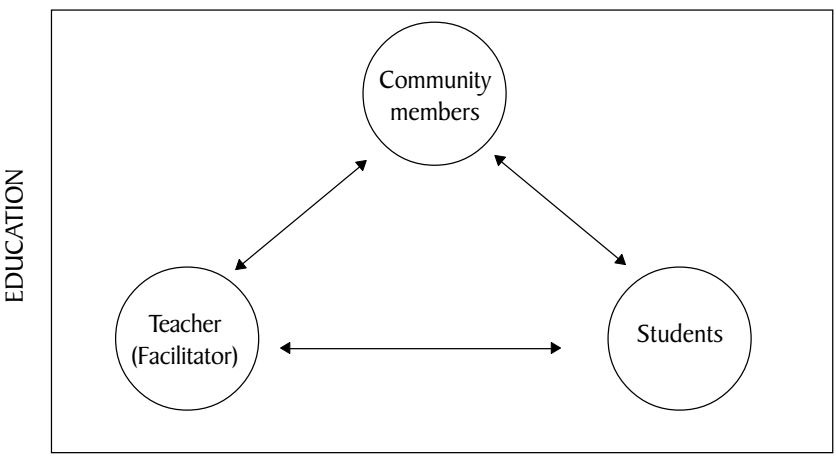
The future of agricultural research

In an earlier section, it was concluded that meaningful agricultural research in the natural farming paradigm could only be done in a village ecosystem context with farmers themselves being the researchers. If this conclusion be accepted, then it appears that present-day agricultural scientists must start from scratch to redefine their role. Do they have any role to play at all? (Natural farmers seem to be getting on with the job on their own quite well, albeit on a very small scale so far.) If we can visualise a role for the institutional scientist at all, then we must question whether they are trained and equipped to play that role. Scientists who are convinced that a change to natural farming is necessary will have to make this enquiry. They must, however, avoid defining a future role for themselves in terms of their inherited scientific mindset and administrative context. If they do not, they may mistakenly think that they will 'do' research in a village setting, or collaborate with farmers to evaluate the technology they have devised in the laboratory or experiment station. In that case they set the research agenda and define the evaluation criteria. They will

have failed to realise that their modern research methodology is, in a natural farming context, invalid and unlikely to lead to useful results. Indeed, their results may be counterproductive.



A. Conventional school education



B. Comprehensive education

Figure 9.2. Conventional school education aims at transferring defined concepts and parcels of information to students. The subject matter generally has no relevance to the community. Comprehensive education fosters an interactive process of learning among teachers, students and community members. New techniques and knowledge are created in this process and shared by all. This model is appropriate for subjects such as local history and geography and local civics, environmental and livelihood concerns. More distant, abstract concerns must be seen to take their rise from these. (Source: UEEC, 2002 a)

The question may be raised: 'but what about basic research? Surely that is best done in the laboratory or the "controlled" conditions of the research station.' Basic research is a search for explanations. In the ecological or natural farming science paradigm it is the construction of macro-explanations. A macro-explanation describes the place of a thing in the structure and functioning of the system of which it is a part, rather than in terms of its component parts and processes (micro-explanations), and therefore cannot be achieved by isolating it from that system. The system of which crops, animals, soil bacteria and ponds are parts is the village ecosystem.

The researcher must continually strive to understand the balance of nature as She seeks expression in a finite situation – a specific farm or village ecosystem – and assist Her to re-establish balance in that system which has been disrupted by previous inept farming. This is the over-riding goal of natural farming research.

The natural balance of a system (farm/ village ecosystem) is something that must be apprehended intuitively, as a living whole, immediately, and not after amassing data and rationally processing it. Rational or discursive thought then must make this intuition explicit to create knowledge that can be shared and on the basis of which a research agenda can be devised. An example here is the quantification of a village ecosystem (see Chapter 1). These two modes of knowing, intuitive and discursive, correspond, in Buddhist metaphysics, to 'non-discriminating' and 'discriminating' knowing. '...knowledge that splits apart self and object and sets them up in opposition is called 'discriminating knowledge', while knowledge that treats self and object as a unified whole is called 'non-discriminating knowledge' (Fukuoka, 1994).' Natural farming research, to be successful, must begin with the acquisition of non-discriminating knowledge. The researcher must begin by putting himself or herself in the picture, so to speak.

Since the variety of farms and villages is almost infinite, one cannot formulate a standardised research methodology such as we in our time learned in the classroom. And, we must not expect to reach an end of our research; we can never develop a tidy 'package of practices'. As long as farming continues, so will our research.

As a preliminary to natural farming research the institutional researcher will usually have to help farmers recover the forgotten Vedic perspective, or, which is the same thing, learn the principles of natural farming. Together the farmer(s) and the institutional researcher need to discuss, define and agree on the research agenda and methodology they will follow. This is the only specific task that I will venture to spell out. The question of details is best left open, giving complete freedom for individual team initiative. A variety of small, tentative initiatives around the country would be, I think, the most sensible way to proceed. The ICAR could play an enabling role here as well as in natural farming education.

As educational and research initiatives multiply, we may begin to see more clearly the ways in which existing administrative structures will have to change. I think we will find it necessary to move away from subject-matter specialisation to an insistence on generalism.[6] Existing disciplinary boundaries would thus tend to dissolve. With a shift from a focus on micro- to macro-explanations, existing disciplines would lose their organisational rationale.

Ultimately, I see the functions of teaching and research merging in a single joint enterprise in which teachers ('facilitators'), students and farmers all participate. Figure 9.2 could be enlarged to express this comprehensive conception.

Notes

1. This is a common example of the fallout of modernisation throughout the South (Norberg-Hodge, 1999).

2. The increase in sugar production was intended, and indeed did, reduce imports (Randhawa, 1983, p. 339).

3. The Other India Press has documented several hundred farmers' experiments in their book *The Organic Farming Source Book* (Alvares, 1999).

4. Improved ecosystem health does also lead to improved food production. The results of a worldwide survey of natural farming experience, or more accurately, of the experience of farmers adopting some form of sustainable agriculture, under rainfed conditions reveal increases in food yields of 50 to 100 percent. These results are

from 91 case studies in which yield data were recorded out of a total sample of 208 case studies from 52 countries involving 8.98 million farmers on 28.92 million ha. land (LEISA, INDIA, 2001).

5. Training in crafts and trades, traditional and more modern versions of them, would, hopefully, with the breakup of the caste system, increasingly become the responsibility of the school. Such training would be available to children of all castes.

6. Inter-disciplinary teams cannot, in my view, produce a generalist perspective. The holistic view of the true generalist comes before the fragmentation of the whole into disciplines; the whole cannot be recreated by trying to assemble the parts. The whole must be grasped intuitively by individual minds as the primary act of knowing.

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A FUTURE FOR RURAL INDIA

M.G. Jackson

This book addresses the rising disempowerment of village communities wrought by three centuries of colonial rule, followed by half a century of chemical-industrial agriculture.

M. G. Jackson is an Indian agricultural scientist who participated in the introduction of the green revolution in the 1960s and 70s. He was one of the first to perceive the fallout from this type of farming, and spent the next thirty years formulating an alternative conceptual model of rural development that envisages individuals and communities that define their own future, rather than submitting helplessly the forces of an increasingly globalised national economy. To do this he has critically surveyed traditional forms of agriculture, modern chemical-industrial agriculture, and the numerous, diverse spontaneous initiatives by rural families and communities across the country, and the scientific rationale for all these. He has also drawn inspiration from personal contact with numerous rural people and communities, and from his own experience as an environmental educator in rural India.

This alternative model envisages rural families and communities rehabilitating their land, and then managing it sustainably. The means to achieving this vision are appropriate education and redressing the social and gender inequalities within the village community, and between village communities and the urban-industrial-corporate sector.

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